THE ST. VITAL CEMETERY (1879-1885): AN OSTEOLOGICAL AND PALEOPATHOLOGICAL ASSESSMENT

A Thesis Submitted to the College of Graduate Studies and Research in Partial Fulfillment of the Requirements for the Degree of Masters of Arts in the Department of Archaeology

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By

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ABSTRACT

In the fall of 1999, human skeletal remains and historic artifacts were discovered on private farmland approximately two kilometres south of the Town of Battleford, Saskatchewan. Document searches and a ground-penetrating radar survey of the property resulted in the discovery that the land was once used as a cemetery for the Catholic Church of St. Vital during the years of 1879 to 1885. Numerous interest groups were brought together in the process of handling this sensitive situation, including the landowners, the Heritage Resource Branch of the Department of Saskatchewan Culture, Youth and Recreation, the Rural Municipality of Battle River, the Roman Catholic Diocese of Prince Albert, and the Battleford Tribal Council. A decision was made to relocate the burials to the current town cemetery. In the meantime, permission was granted for the University of Saskatchewan to play the lead role in the excavation and analysis process. The partial and complete skeletal remains of thirty individuals were recovered, and in addition to a basic osteological analysis of the individuals that included sex determination, age at death and population affinity, a detailed assessment of the pathological conditions was also undertaken. The document and artifact analyses will be the subject of a separate thesis by Colette Hopkins.

Acknowledgements

I would like to thank many individuals for their support and encouragement during the process of developing this thesis. First and foremost, I would like to thank my supervisor, Dr. E. G. Walker, who was always willing to answer any of my questions and provided tremendous support throughout the project. A thank you also goes to my committee members, Dr. M. Kennedy and Dr. D. Meyer, for their helpful comments.

I would especially like to recognize the support of my fellow graduate student, Colette Hopkins. When I realized that the St. Vital project had the potential to become rather substantial, I understood that the best decision was to split the project in two. I was fortunate that Colette agreed to take on the other half as her enthusiasm and work ethic were especially inspiring.

A special thank you to Carlos Germann and John Brandon of the Heritage Resource Branch of the Department of Culture, Youth and Recreation. With their support and guidance, the excavation went very smoothly. Thank you also to the Heritage Foundation as the project was partially funded by the Government of Saskatchewan through a Heritage Foundation Grant.

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Many individuals were involved in the decision-making process regarding the cemetery recovery. Thank you to the Roman Catholic Diocese of Prince Albert, who also provided financial support, the Rural Municipality of Battle River, who provided the heavy machinery and operators, and the Battleford Tribal Council. A special thanks to Pauline Ford, the archivist for the Diocese. Her enthusiasm for learning about past history was inspiring.

Thanks to Barb Neal, who constantly let me bend her ear on so many occasions. I'm so glad that we've had the opportunity to share an office. You are such a wealth of information!!

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CHAPTER ONE: Introduction

Cemeteries offer a link to the past. Grave markers are often used, but they are susceptible to decay or destruction if they are made of materials such as wood. Such markers may also have been moved from their original location and subsequently are no longer associated with the original interments. Unfortunately, unmarked burials are sometimes found accidentally when land is processed for agricultural or developmental purposes, resulting in the disruption of human remains. It is important that a situation such as this be handled with care and respect. This is the approach that was taken with the excavation of a recently rediscovered nineteenth century Roman Catholic cemetery associated with the Mission of St. Vital. These historic burials provided a unique opportunity for scientific study that included the disciplines of osteology and paleopathology.

The St. Vital cemetery was located two kilometres south of the Town of Battleford, Saskatchewan, where it was originally used in the late nineteenth century (1879-1885). Due to the fact that the burials were disturbed and on private land, it was deemed appropriate to recover the remains in an orderly fashion and reinter the individuals in the current Town of Battleford Cemetery. In the meantime, this was a valuable opportunity to learn more about a late nineteenth century population through skeletal analyses.

1.1 Paleopathology

A major component of this project was to analyze the skeletal remains for signs of pathological conditions. Paleopathology, or the study of ancient disease, allows for an understanding of past health conditions and their relation to society. The study of a skeletal collection is a unique situation where health indicators for the population can be studied instead of just basing conclusions on one individual.

The overall conditions of the dentitions in the cemetery population were assessed. A discussion of caries, impacted molars, attrition, enamel hypoplasia, and supernumerary teeth is presented in chapter six. Dental pathological conditions can be used to determine an individual's diet as well as their social status.

Congenital abnormalities are caused by intrauterine changes as a result of faulty genetics or development. One individual recovered from the St. Vital cemetery was observed to have aural atresia, a congenital condition resulting in an absent external auditory canal. This condition will be discussed further in chapter seven.

Skeletal evidence of trauma includes fractures, dislocations, amputations, and cranial deformation. It is possible to speculate on the occurrence of occupational hazards and interpersonal conflict when signs of trauma are evident. In the St. Vital cemetery population, one individual demonstrated evidence of a healed fracture of the right fifth metacarpal. In addition, the oldest individual possessed an abnormal cranium, with pronounced flattening particularly in the occipital region. Flattening of the occipital has been associated with the use of cradleboards in infancy.

Spondylolysis, which is the failure of a vertebral arch to fuse to a vertebral body, has often been associated with both traumatic conditions and congenital conditions.

Evidence of spondylolysis was visible in two individuals from the St. Vital cemetery population. This condition, along with fractures and cranial deformation, will be discussed in chapter eight.

An overabundance of lead in culturally created environments has impacted the health of many populations. Lead poisoning is considered to be a metabolic disease as it can be absorbed through the skin, or inhaled, and later distributed to all the tissues in the body. Lead accumulates in bone over time, and the concentration can be determined through chemical analysis. Numerous bone and tissue samples were sent to the Department of Geological Sciences at the University of Saskatchewan to have the concentration of various chemical elements assessed. This avenue of research was generated by the concern with arsenic exposure during the excavation. In the late 19th century, arsenic was used in eastern Canada to embalm people prior to burial (Konefes and McGee 2001). Two of the individuals from the St. Vital cemetery showed the presence of preserved soft tissue. When the chemical testing was complete, it was apparent that the arsenic levels were similar to the background level. However, a number of individuals had high lead levels. Metabolic diseases such as lead poisoning will be discussed in chapter nine.

Evidence of degenerative joint disease was identified in the skeletal remains of two individuals. Joint degeneration is not only an indication of arthritis and joint problems, but it is also used as an indicator of age because bone will show normal signs of degenerative disease as an individual ages. Osteochondritis dissecans, a circulatory disorder, is a condition that results in similar types of bone erosion due to the formation of necrotic bone fragments. This condition was found in one member of the St. Vital cemetery population. Both degenerative joint disease and osteochondritis dissecans will be discussed in chapter ten.

As we are dealing with a time period prior to the use of antibiotics, many individuals likely succumbed to bacterial and viral infections. It is sometimes possible to see this osteologically, although it is important to note that only a small percentage of skeletal remains will show any evidence of disease (Aufderheide and Rodriguez-Martin 1998:118). The infection will either result in a quick death with no skeletal involvement, or the individual recovers without any signs of infection. The diseases present in the late nineteenth century and the impact on bone will be discussed in chapter eleven.

1.2 The Study of Historical Cemeteries

Historical archaeology is an area of research where the material culture is studied from past populations, but the opportunity to associate written documentation with the artifacts is also available. There are many different avenues to follow within the field of historical archaeology, but one area, which is as interesting as it is complex, is the study of cemeteries. The amount of knowledge that can be obtained from a cemetery is vast. Mortuary practices, including different burial treatments and locations of cemeteries, reflect what cultures feel are important. The human skeletal remains themselves have stories of their own to tell. Demographic parameters such as age, sex, and stature help to define the population that once existed.

Cemeteries are fascinating for the living, as they represent the people who have been here before us. Different methods have been used for the disposal of human remains, but recently in the modern world, one of the most common has been the use of a formal cemetery. The word 'cemetery' comes from the Greek word 'kaimeterion' and from the Latin word 'coemeterium', which means sleeping chamber (Iserson 1994:516).

During the time of early Christianity, people were not buried within a city. However, in A.D. 752, St. Cuthbert received permission from the Pope to use the areas next to the churches as the burial grounds. In Medieval times, a cemetery was used for refuge and asylum. Houses were built within the cemetery, and often people would stay within the area for stretches of time, as they were not required to pay taxes. Cemeteries have been used as meeting places, fairs, and markets. In the late eighteenth century, Parisians objected to the closing of the Paris Cimetière des SS. Innocents, as it was a place of interaction for citizens of different social strata (Iserson 1994:518). In modern day Egypt, many people still live within cemetery boundaries due to the shortage of housing (Iserson 1994:517).

In North America, prior to the arrival of the Europeans, mortuary customs varied among the respective groups. On the Plains, it was not common to inter individuals in formal rows in cemeteries with headstones for each individual. One of the precontact practices across the northern Plains was the bundle burial. The deceased were left to the elements to skeletonize, sometimes on a platform placed in a high location. Due to weather and scavenging, many of the bones were moved or dragged away, and only a few would remain for burial. At a later date these remaining bones were bundled up and transported to a traditional burial ground (Bryan 1991:72).

With the arrival of the Europeans, different mortuary practices became common. Cemeteries were more formalized, and markers would be used to indicate the location of the burials. Records of names, ages, and causes of death are sometimes associated with historical burials. Different religious communities followed their own customs, but the locations of the burials were often associated with a place of worship such as a church. Many of these churches were subsequently relocated, resulting in the abandonment and disappearance of the cemetery from the landscape. The burials are then forgotten until such time when they are rediscovered to the surprise of the land developers and landowners.

1.3 Ethical Considerations of Cemetery Research

When a cemetery is discovered, it gives the scientific community an opportunity to study a culture's history. In recent times the study of historical cemeteries has been on the rise. There have been many objections to the study of burials of ancient Native Americans, and many early skeletal collections are no longer available for scientific analysis (Ubelaker 1995). The study of skeletons and the associated gravesites was formerly approached with an ethnocentric bias. Physical anthropologists and archaeologists limited the focus of their studies, and they did not include incorporation of views and ideas from the present culture associated with the remains being studied. This has resulted in feelings of resentment, and countries such as the United States have now enacted laws, such as NAGPRA, restricting access to Native American burials and funerary objects. Due to these concerns many of the collections have now been reinterred.

The reburial controversy is a result of a conflict in cultural values. Different cultural groups base their values on their own system of ethics. It has been noted that in dealing with conflict and the issue of values and ethics, two approaches can be taken. The first is dominance or the use of power by one over the other with the intent of suppressing the alternative viewpoint. A second approach is tolerance. This requires the ability to reach a compromise with mutual respect and the allowance for full access to information regarding the issue of concern (Goldstein and Kintigh 1990). Tolerance will enable both sides to become more aware of the other's ethical system. It will also result in a more thorough understanding of studies involving cemeteries and human remains.

When a cemetery is to be excavated, either due to circumstances such as rediscovery from construction or a planned excavation of a known site, it is important to let the various individuals and communities know about the undertaking. Permission is a necessary step for a smooth recovery, and it helps to prevent any unnecessary surprises (Goldstein 1995). The St. Vital cemetery project was initially co-ordinated by the Heritage Resource Branch of the Saskatchewan Department of Culture, Youth and Recreation. The disruption of the unknown St. Vital cemetery resulted in the collaboration of many groups of individuals including the landowners, the Rural Municipality of Battle River, the Roman Catholic Diocese of Prince Albert, the Battleford Tribal Council, and the University of Saskatchewan.

One example of a complex site where permission was required from different sources was the excavation of the Russian Orthodox cemetery site at Fort Ross in Sonoma County, California (Goldstein 1995). The goal of the researchers was to understand the trials and tribulations of a community who had faced the challenges of a new environment and interaction with different cultures. Through both skeletal analysis and research on the material goods recovered from the cemetery excavation, it was possible to see how these challenges were faced.

Prior to excavation, permission was required from not only state officials and descendants, but it was also important to make the Russian Orthodox church aware of the research goals and to ask the church if they had anything that they would like to see accomplished. Researchers received the permission from the church for the excavation because the church had their own concerns regarding the run-down condition of the cemetery. The Russian Orthodox church also believed that the interred individuals were not receiving the respect and recognition that they felt the individuals deserved. The church agreed to the excavation because it fit in with their plan to reinter the individuals in a more appropriate manner (Goldstein 1995).

The question of whom is asked for permission is an important one, as it often involves talking to many different groups so that each has a say in the process. Respect is paramount when dealing with a sensitive issue such as the treatment of human remains. Attitudes and preferences on the approach to the matter can be quite different between different people and organizations.

Another component involves the landowners. Should a cemetery be discovered on private land, it is very important to receive permission from the landowners in order to have access. It is almost certain that the owners will want to do anything necessary to make sure that the issue is properly dealt with. They are an integral part of the equation from which permission is required, and it is very necessary to keep them informed.

Cemeteries from the historical period potentially have associated documents, which can add valuable information. Documents include sources such as church records that may indicate the names, ages, and causes of death of the individuals who were buried in the cemetery. Municipal documents can give an indication of population demographics and of ethnic backgrounds. Due to the vast amount of information that can be acquired from studying an historical cemetery, the St. Vital cemetery analysis was separated into two components. This thesis will focus on the recovery and analysis of the skeletal material. A second thesis by Colette Hopkins, a fellow graduate student in the Department of Archaeology at the University of Saskatchewan, will focus on the documentary and artifact analysis.

CHAPTER TWO: Project History and Physical Setting

2.1 Site Discovery

In October of 1999, Helen and Neil Dyck, while trying to level a sandy knoll just north of their house, discovered bone fragments and historical artifacts on their property. Artifacts that were collected included NWMP buttons, a clay pipe, trade beads and nails. The Battlefords RCMP detachment was contacted who in turn called Dr. E. Walker from the Department of Archaeology at the University of Saskatchewan. Dr. Walker assessed the bone fragments and confirmed that they were indeed human. A metal detector was brought to the scene, and during this time, additional buttons and beads were found. The surface scatter was recovered and sent to the University of Saskatchewan for further analysis.

The following year, more skeletal remains and artifacts were recovered on the surface, and these were also sent to the University of Saskatchewan. The Heritage Resource Branch of the Saskatchewan Department of Culture, Youth and Recreation became involved and determined that further testing and investigation were necessary. Initial research indicated that there was a cemetery in the area, once used by the St. Vital Roman Catholic Church, originally located two kilometres south of the Town of Battleford. Historical records were found that pinpointed the location of the cemetery. R.C. Laurie, a local surveyor, performed a survey of the Battleford to Swift Current trail in 1886. He documented the location of the St. Vital Cemetery west of the trail on the south end of Battleford with a label of 'R.C. Graveyard' on the survey (Fig. 2-1).

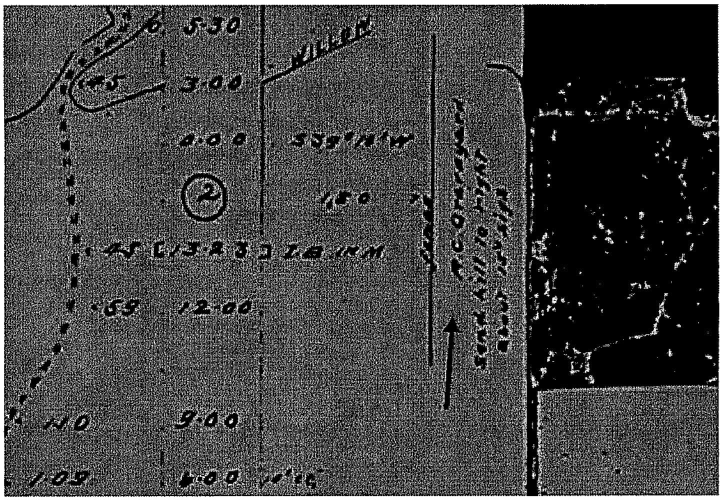

Figure 2-1: Section of R.C. Laurie's survey that indicates the location of a Roman Catholic cemetery (Laurie 1886).

The Roman Catholic Diocese of Prince Albert maintains the records of local parishes, from which their archivist, Pauline Ford, was able to locate the burial register for the St. Vital Cemetery. In the winter of 1877, the St. Vital Mission was established by the Oblates of Mary Immaculate to encourage the local community to adopt a Christian lifestyle. The church was rebuilt in 1880, east of the first structure (Fig. 2-2). The population of Battleford at this time was approximately one hundred individuals and consisted mainly of Catholic Métis. In 1883, the church was again rebuilt south of the North Saskatchewan River, where the Town of Battleford is now situated (Horacki 1977).

The St. Vital Cemetery was used for interments between the years of 1879 and 1885. After 1885, individuals were interred in the NWMP cemetery in the town site until 1889 when land was designated for a town cemetery in a field near Battleford. By the early 20th century, the Crown-owned land used for the original St. Vital Cemetery was sold for residential use. Thirty-four individuals were listed in the St. Vital burial register between the years of 1879 and 1885, and it is assumed that the individuals were interred in the original cemetery location.

R.C. Church, Battleford, Sask.
(Sketch by Sidney P. Hall - 1881)

Figure 2-2: Sketch of the second St. Vital church (Horacki 1977)

In July of 2000, the Heritage Resource Branch commissioned a ground-penetrating radar (GPR) assessment of the Dyck property. GPR is a non-destructive method that has the capability to detect varying densities and soil disturbances through the use of radar wave emission directed into the ground (Davenport 2001). Disrupted soils from grave digging will often have varying electrical and magnetic properties (Bevan 1991). Estimates of the depth and shape of the anomalies can be determined from the recorded data.

The St. Vital cemetery GPR survey was established on a two-metre grid across the 50m x 50m site. Fifty-six anomalies were found, but only ten tested positive for burials containing skeletal remains. Eight of the positive anomalies were associated with adult burials, while two were associated with young children. One anomaly tested positive for a burial feature that contained an empty coffin. After the completed excavation, three additional adult burial features and six infant burial features were discovered through the use of heavy equipment (Fig. 2-3, 2-4 and 2-5).

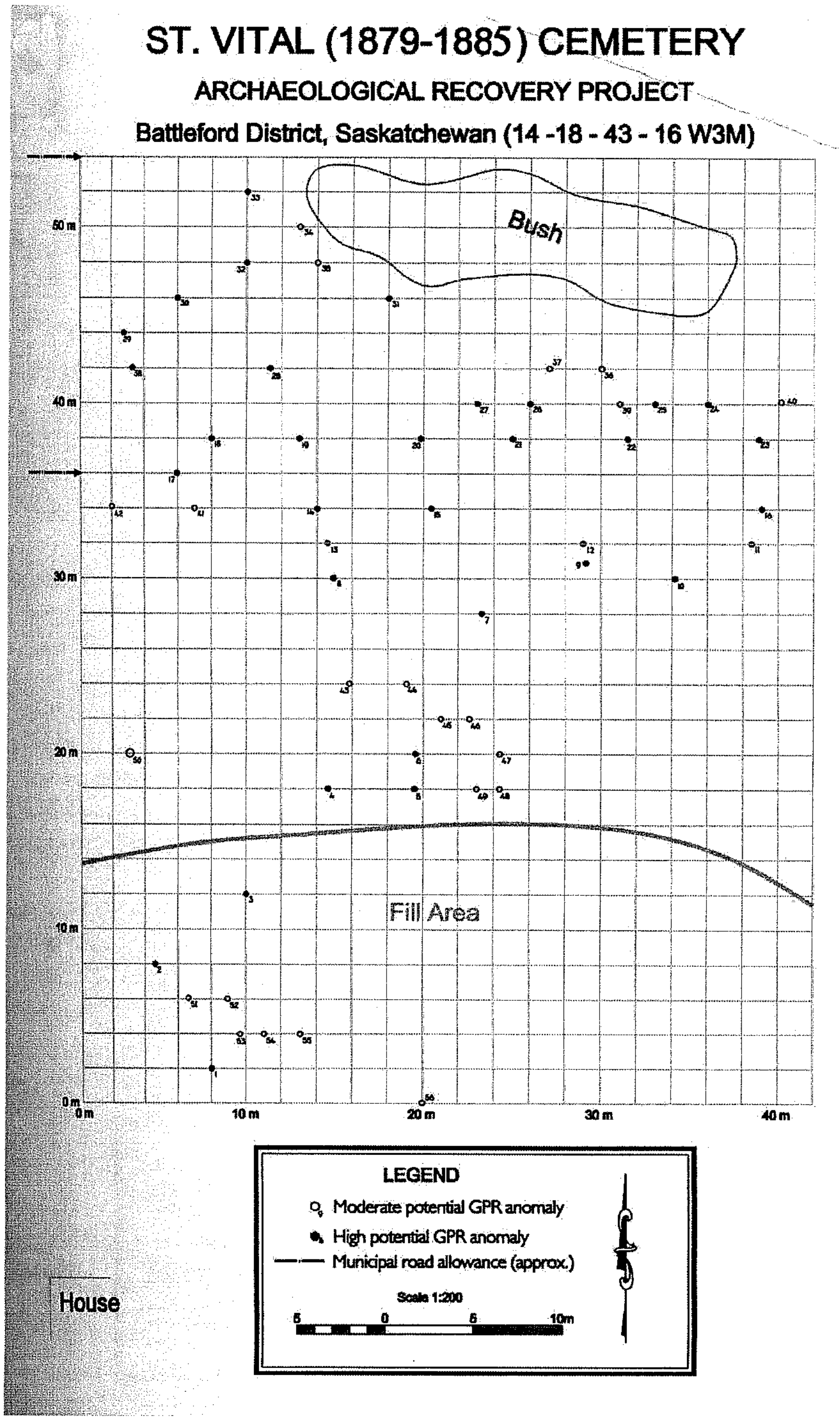

Figure 2-3: Map of the GPR anomalies. Courtesy of the Heritage Resource Branch of the Department of Culture, Youth and Recreation, Government of Saskatchewan.

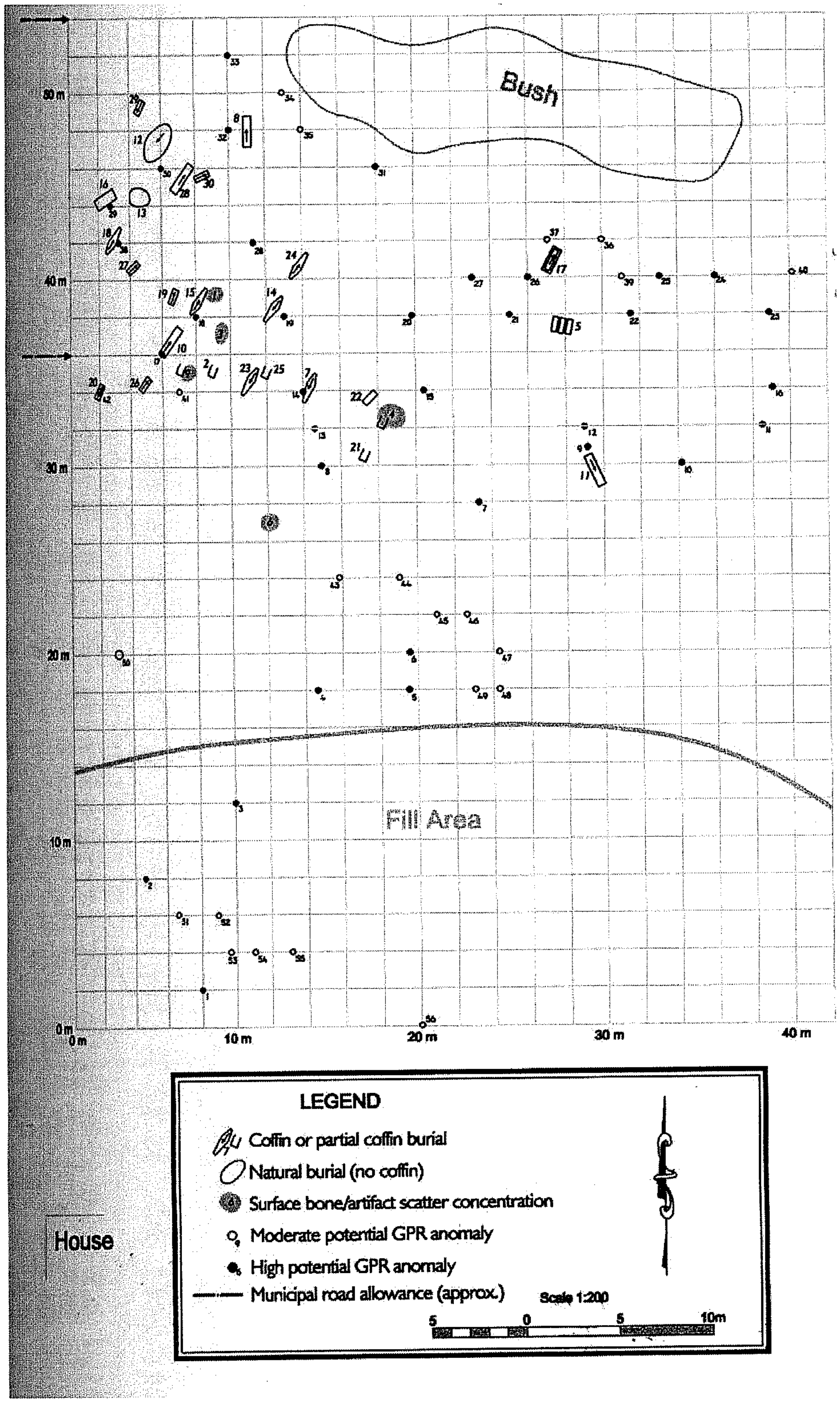

Figure 2-4: A map of the cemetery indicating both the GPR anomalies and the burials. Courtesy of the Heritage Resource Branch of the Department of Culture, Youth and Recreation, Government of Saskatchewan.

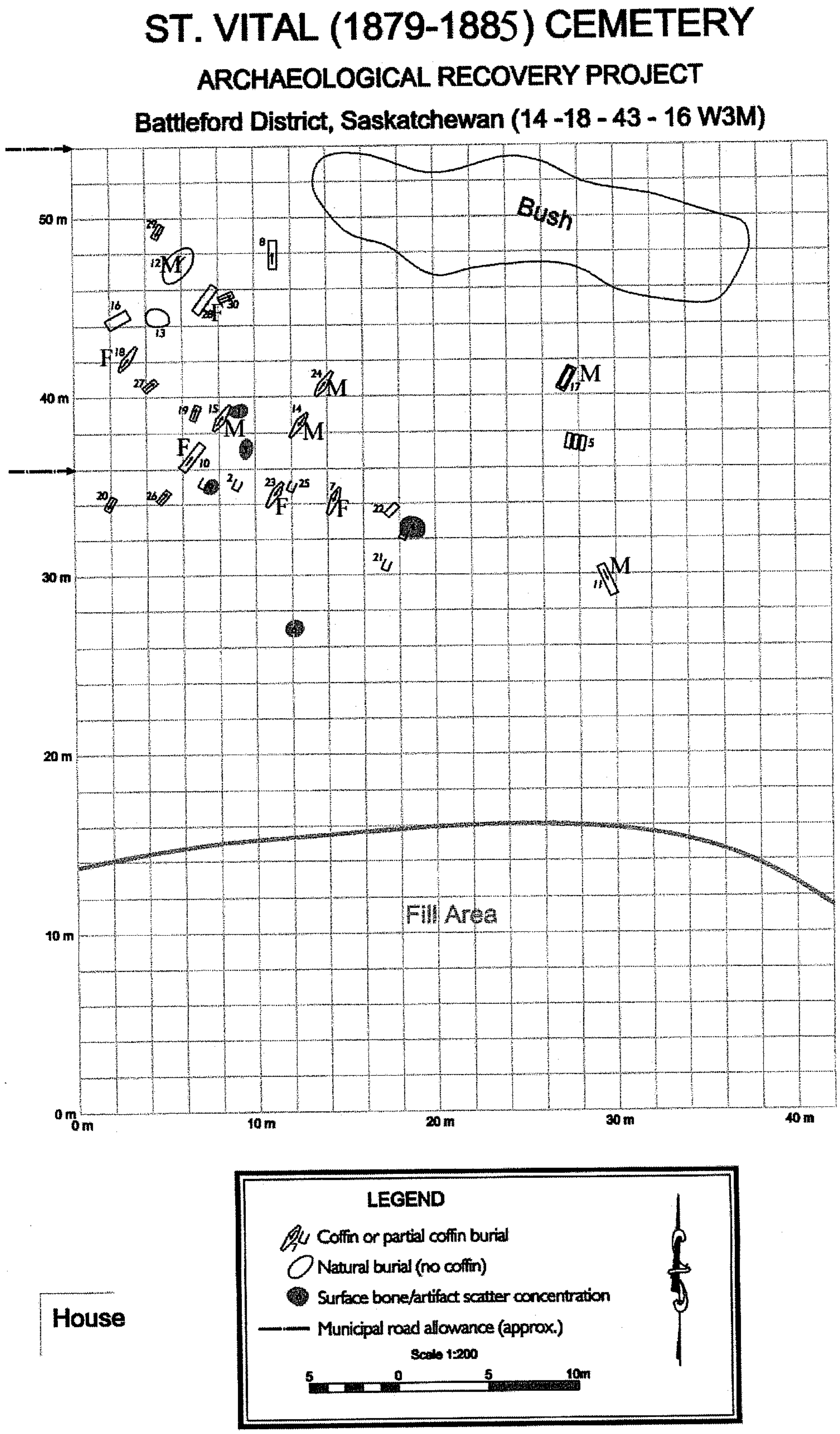

Figure 2-5: Map of the cemetery arrangement. Courtesy of the Heritage Resource Branch of the Department of Culture, Youth and Recreation, Government of Saskatchewan.

2.2 Geographical Setting

The site was named St. Vital (1879-1885) and given the Borden designation FeOb-3. It is located in the Rural Municipality of Battle River, No. 438 with a legal description of NE of NW S.18 Twp.43 Rge.16 W 3 M (Fig. 2-6 and 2-7). Two kilometres north of the site is the Town of Battleford, which is located near the confluence of the North Saskatchewan and Battle Rivers. Battleford played a significant role in the late nineteenth century, as it was the capital of the Northwest Territories from 1876 to 1883.

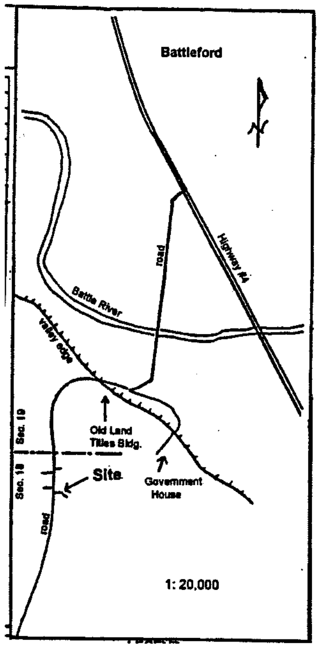

Figure 2-6: Site location. Courtesy of the Heritage Resource Branch of the Department of Culture, Youth and Recreation, Government of Saskatchewan.

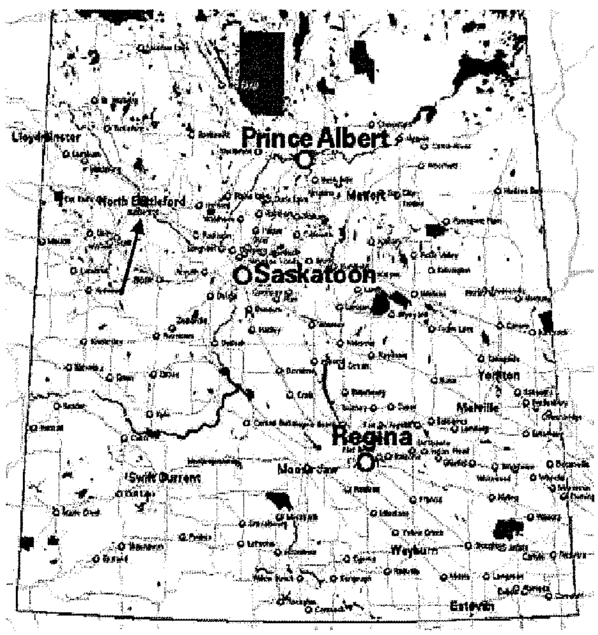

Figure 2-7: Location of Battleford within Saskatchewan.

The cemetery was situated in sandy soil (Fig. 2-8), in a northward extension of the Eagle Hills escarpment south of Battleford. The surrounding area is part of the aspen parkland ecoregion, a transitional area between the southern grasslands and the northern forests. This region contains a high percentage of uncultivated land. Prior to the rediscovery, the site of the cemetery was never cultivated, but was used as a grazing pasture.

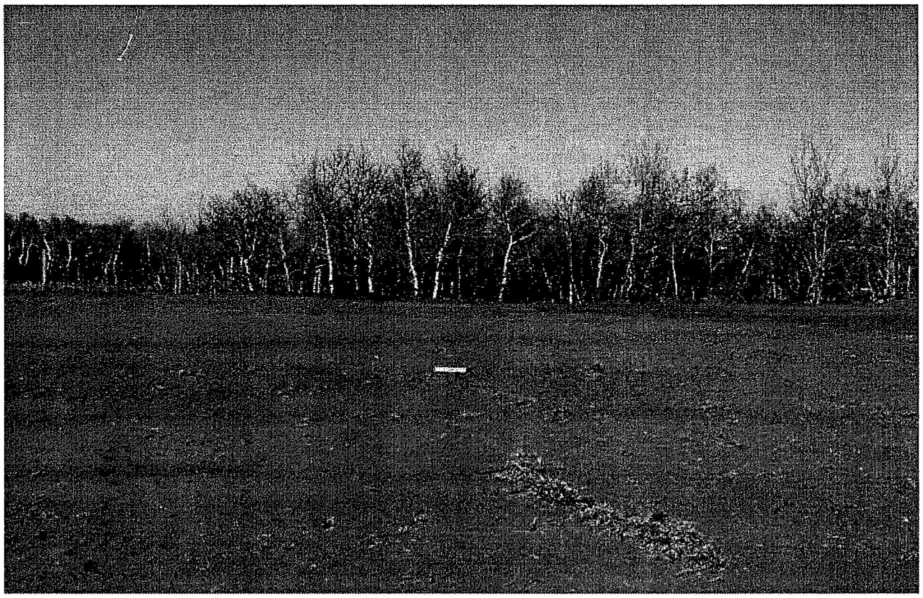

Figure 2-8: A view of the sandy soil conditions of the site prior to excavation. Photo courtesy of the Heritage Branch of the Department of Culture, Youth and Recreation, Government of Saskatchewan.

CHAPTER THREE: Excavation and Analytical Methods

3.1 Methodology

With the advent of new technology, the excavation and recovery of individuals from historic cemeteries have become more manageable. As mentioned earlier, ground-penetrating radar is a non-invasive mechanism that assists researchers in determining potential gravesites. Multiple test excavations and the unintentional disruption of remains can be avoided (Ubelaker 1995). It is an important first step in the excavation of an historical cemetery, as the information gathered can lead to the estimation of the number of burials. These data are also necessary for the determination of the crew size and the amount of equipment required for the excavation.

Most burials associated with the historical period in North America are found with coffins. Depending on the weather and ground conditions, wood coffins may decay at a fast rate. Often, the only signs that an individual was buried in a coffin are the remaining nails, which were used in the box manufacture. Handles are occasionally found, as they were historically made of a hard metal. Some researchers have studied these handles as a way of determining status in the buried population. The absence of handles may reflect that the individual was from a lower status family that had limited resources (Winchell et al. 1995). Designs and inscriptions on handles often signify whether the deceased was a child or adult and of high or low status. For example, children were historically identified with innocence, purity and domesticity, and this was reflected in the handle motifs (McKillop 1995).

3.1.1 Taphonomy

The recovery process of the skeletal elements may vary due to differential preservation. Some of the more common fragments that are normally recovered are the shafts of the long bones such as the humerus, femur, or tibia. These bones have a higher percentage of cortical bone, which is a harder, denser material that preserves fairly well in non-acidic soils. Other elements such the pubic bones are more delicate, and they are not recovered as often. There are also many skeletal elements that are very small in size, such as the phalanges and interior portions of the cranium. If excavators are not careful, these bones can often be overlooked in the recovery process.

The skeletal elements from middle-aged adults are easier to recover due to their larger size and higher mineral component (Walker 1995). This leads to an age bias towards middle-aged individuals from excavated cemeteries, which may conflict with records that might suggest higher numbers of the young and elderly.

Researchers have also found that there is differential preservation between males and females. Many women are gracile, while other women are susceptible to bone-loss in advanced age due to hormonal imbalances. These factors may result in the identification of fewer female skeletal remains.

Taphonomy plays a crucial role in the recovery of human remains. There are many actions that can potentially have an effect on a burial. One well-known process is the intrusion into the burial by small burrowing rodents. Small gnawing marks or disturbance of the skeletal elements are evidence of their presence.

The pH of the soil surrounding the burial can also play an important role. Acidic soil may increase the speed of the tissue and bone degradation. It is helpful to test the soil acidity prior to an excavation, as it may help in determining the amount of recoverable remains (Gordon and Buikstra 1981).

Different cultural practices may have a taphonomic effect. The postmortem treatment of a body may influence how long the remains will preserve (Nawrocki 1995). The location of the interment will also have an impact. Both aboveground and below ground burials have been practised by various cultures. The aboveground burials were sometimes the preference if there was a high water table.

Material items are often added to burials. They are not only significant on a cultural level, since they can reveal a lot about both the deceased and the living at that time, but the material inclusions may also affect the skeletal remains and other personal items. Some metal artifacts such as jewellery may stain bone surfaces, but they also help to preserve some fabrics and leather. Similar findings have been seen with the hardware materials used on the coffins, including the nails and the handles (Nawrocki 1995).

The burial depth is an important factor to recognize. For a below ground burial, cultural practices of burying the dead in shallow graves can have a great impact on the amount of preservation. Shallow burials in colder climates are within the freeze-thaw zone, and constant freeze and thaw action alters bone tissue quite dramatically. Burials that are not very deep are also affected more readily by animal and plant activity. Plant roots can cause extensive damage and leave recognizable marks.

The actual act of excavation resulting in exposure of bone can leave taphonomic signatures related to weathering. Opening a burial results in the exposure of the remains to the aboveground elements such as sun, wind and rain. Only a short amount of time in the sun can result in damage to the skeletal elements from the result of too much drying (Nawrocki 1995).

3.1.2 Excavation of the St. Vital Cemetery

It was important that the excavation of the St. Vital Cemetery population be undertaken in an orderly and efficient manner. The Roman Catholic Diocese of Prince Albert and the Government of Saskatchewan, through a Heritage Foundation Grant, shared the excavation costs. In June of 2001, the recovery of the skeletal remains and analyses of the burial features were initiated. In addition to Carlos Germann and John Brandon from the Heritage Resource Branch of the Department of Culture, Youth and Recreation, a crew of three University of Saskatchewan archaeology graduate students was recruited to assist with the fieldwork. The University of Saskatchewan archaeology field school was also brought out to the site for one afternoon of recovery work.

Normal archaeological methods were used in the locating, mapping and removal of the burial features. With numerous individuals involved in the excavation, a standardized form was created for the acquisition of specific information. Data were gathered on the burial type (extended, flexed or reburial), burial dimensions, preservation quality, completeness of the remains, and the cultural materials found with the burials.

Shovels were used initially, and once part of a burial feature was uncovered, the work continued with trowels. For those individuals who were found within a coffin, the soil from around three sides was removed for exposure of the box profile. Measurements were taken of the box dimensions followed by removal of the lid. Wood samples were saved for future analyses. The individual skeleton was then cleared of all soil and debris. Prior to disarticulation, many photographs were taken to ensure that information about body positioning and the location of artifacts *in situ* would be maintained. Paper bags, which were used to prevent further bone destruction by allowing moisture to escape, were labelled with the skeletal element and side. They were used to store the remains in an organized fashion to assure that the analytical portion of the research would run smoothly and accurately. When anomaly testing was finished, and the positive 'hits' were excavated, heavy machinery was brought in to strip the site in a controlled fashion. This was to ensure that the cemetery recovery was complete. This process resulted in the discovery of three additional adult burial features and six infant burial features.

When the area was determined to be clear, the skeletal remains were packed in boxes and transported to the University of Saskatchewan for analysis. The partial and complete skeletal remains of twenty-two individuals were recovered. These excavations were conducted under the permit no. 00-001, issued by the Heritage Resource Branch of the Department of Culture, Youth and Recreation.

3.1.3 Bioarchaeological Parameters

Once an excavation is complete, the next step is the analysis. With careful observation, an abundance of information can be gathered from skeletal remains. Many scientific studies have shown that the sex of the individual, the age at death, the stature, and signs of disease can be determined quite accurately (White 2000:337).

The innominate bones and the cranium are important areas in the determination of sex (Bass 1995:208). The number of females versus the number of males in a burial population can be a significant ratio and may help in understanding the culture and their experiences. Perhaps one sex was more susceptible to disease or there was a greater proportion of one sex over the other, such as in a frontier situation.

The age at death is another variable that is routinely determined when analyzing a cemetery population. Dental indicators are very useful in younger individuals as teeth erupt at known intervals, and the assessment of age can be quite accurate if the individuals still have deciduous teeth or a mixed dentition (Hillson 1996:118). Another indicator is that epiphyseal fusion occurs at known ages (Scheuer and Black 2000:5).

An individual's age at death is an important variable that can give an indication about the respective population as a whole. For example, historical cemeteries that were associated with military activity may have more skeletal remains of younger individuals. Some cultures were forced to send some of their youngest citizens into battles, and this will be reflected in the cemetery population. The age of an individual can also be an indicator of disease or an epidemic situation. Younger individuals who did not live to the expected age at that time may have succumbed to a serious illness. Some disease processes leave traces of evidence on the bone, but many do not, especially if the illness is short but severe.

Stature estimation is another variable that may help in defining a skeletal population. An individual's height can be determined by measuring the length of long bones such as the femur. Other elements such as the humerus and tibia are often measured, but the estimated stature is most accurate when combinations of long bone lengths are used. An estimated stature can help in age definition if no other age indicators are available. If adult bones are smaller than expected, this may indicate the impact of a childhood illness or disease.

Skeletal differences can be used to indicate an individual's ancestry. These variations can be found on elements such as the cranium where some populations have slight morphological differences. For example, individuals with European ancestry often have distinctive fossae superior to the maxillary canines, while Native American populations show the presence of a shovel-shaped appearance on the lingual side of the incisors. Indicators such as these are helpful in determining the ancestry of the individual and the skeletal population (Gill 1995).

Bioarchaeology, the study of skeletal tissue from ancient populations, is an area of research that also searches to understand the evolution of certain medical fields such as surgery. By analyzing a population from a known time period for osteological evidence of surgical practice, it is possible to compare the appearance of the procedures with historical documentation on those particular procedures. Currently, evidence of surgical experimentation and autopsy is rare in North American historical skeletal samples (Owsley 1995).

Many diseases do not leave any evidence on bone, but traces of the bacterial or viral DNA associated with the disease-causing organism may still be present. Tuberculosis, for example, a disease that is still present in some communities today, was a problem for many individuals in the pre-antibiotic era. If a person rapidly succumbs to the disease, the bone tissue will not show any evidence of the illness. However, the bacterial organism *Mycobacterium tuberculosis*, the instigator of the disease, may still have minute traces of its DNA left in the bone tissue. Recent molecular advances such as the use of polymerase chain reaction techniques to amplify DNA, enables researchers to determine if the individual had the disease without having a clear indication from a gross pathology.

3.1.3.1 St. Vital Cemetery Population Laboratory Analyses

A cemetery study is a unique opportunity to perform an osteological analysis on a population as opposed to just a single individual. Initially, the skeletal remains were carefully cleaned with a dry brush to remove as much of the soil and debris as possible. A laboratory assistant was hired at this stage to help with the cleaning process.

The next step involved the completion of an inventory form for each individual. A standard osteological form, designed for skeletal analyses of archaeological burials was used. Each adult is comprised of 206 separate bones, while juveniles and infants have considerably more, taking into account that their bones are not completely formed, and epiphyses do not fuse until certain ages. The individuals were assessed for the completeness of skeletal elements. Fragmentary remains represented many of the individuals.

An inventory was also completed of bone fragments that were recovered from the surface of the Dyck property in the fall of 1999 and spring of 2000. Most of these fragments were from juveniles and infants and could not be matched with any of the younger individuals recovered in 2001. A few of the surface adult bone fragments were identified as belonging to individuals recovered in 2001. The final count of individuals recovered from both the 2001 excavation and the surface scatter from previous years was thirty. This final number includes eleven adults and nineteen juveniles and infants, with very fragmentary skeletal remains representing seven of the individuals.

A dental assessment was performed on each individual. This included charting the presence or absence of teeth, the status of the amount of wear or attrition on each tooth, as well as determining any evidence of caries and calculus. The degree of shovelling found on the upper incisors was also noted.

Traditional methods were used in the determination of the sex of each adult, such as the analysis of the pelvic elements and crania. It was estimated that of the eleven adults recovered from the St. Vital cemetery, six individuals were male and five were female. Sex was not determined for the juveniles and infants, as there is no reliable method for sex determination when an individual has not yet undergone the changes that occur during puberty.

The next step in the process was to determine the age at death for each of the individuals. In this case, it was much easier to determine the ages of the juveniles and infants, as tooth mineralization and eruption take place at known times, which allows for accuracy in age estimation. With the adults, the ages were determined through the assessment of different features such as the amount of changes found on the pubic symphyses and auricular surfaces on the pelvic elements. Sternal rib ends are also used in age determination as they have a characteristic appearance in each age group.

The ancestry of each adult was estimated by analyzing cranial features such as the shape of the nasal profile, and lack or presence of a nasal sill. With this population, the shovel-shaped incisor trait was commonly seen in most of the individuals, suggesting Native American ancestry.

Cranial and post-cranial non-metric traits can be used to determine potential 'relatedness' between individuals. This was attempted through the analysis of fifty-three non-metric cranial traits, including the presence or absence of various ossicles or foramina, as well as the analysis of over fifteen post-cranial non-metric traits, such as the presence or absence of facets. This examination was only performed on the adult individuals, but due to the small sample size of eleven adults, the results were inconclusive.

Numerous measurements were taken on each skeletal element of the eleven adults, as well as some of the infants and children. Fifty-two measurements were taken on each adult cranium, including cranial length, cranial breadth, nasal height, and so on. Post-cranially, fifty-five measurements were taken, such as maximum humeral length and femoral length (Appendix A1 and A2).

CHAPTER FOUR: Description of the Adult Skeletal Remains

This section contains a burial by burial description of the skeletal remains based on the laboratory analysis. A table containing a summary of the skeletal information is located at the end of this chapter (Table 4-1). Field descriptions will be included, as well as a listing of the cultural items recovered with each individual. Further information on burial orientation, coffin size and shape, and detailed artifact analyses can be found in the corresponding thesis.

4.1 Feature 7 Burial Description and Cultural Items

Grid location: 32-33.5N/14-15E

This burial feature was discovered through the testing of anomalies found during the process of using ground-penetrating radar. A wood coffin was located that contained the skeletal remains of a female, whose age at death was greater than sixty years. The individual was lying in an extended supine position with the arms crossed on the pelvis. No cultural items were recovered, but fabric samples were retained from both the coffin interior and exterior.

4.1.1 Sex Estimation

The Phenice method (White 2000:367) was used to discern that the individual had many female pelvic traits such as the presence of a ventral arc, subpubic concavity, and sharp medial aspect of the ischiopubic ramus. Also, a preauricular sulcus was present, and the greater sciatic notch was relatively wide. The cranium also had female features, as the forehead was vertical, the palate was deep, and the mastoids were small.

4.1.2 Age Estimation

The age at death of the individual could not be determined with any more precision, because once an individual is older than sixty, the aging methods are no longer accurate. According to the Suchey-Brooks pubic symphysis scoring system (Suchey and Katz 1998), this individual is estimated to be in phase VI, and with a 95% range of confidence, the age at death may have been between 42 and 87 years. The auricular surface of the ilium was also examined, and following the morphology described by Lovejoy et al. (1985), the surface was in phase eight with macroporosity and irregularity. This places the individual at greater than sixty years of age at the time of death. Additional sources of information came also from the high number of fused cranial sutures (Meindl and Lovejoy 1985), and the degenerative changes found on the lumbar vertebrae and various joint surfaces.

4.1.4 Ancestry

Population affinity is difficult to assess, and a combination of factors is needed to determine the ancestral population of an individual. When assessing this particular individual in regards to the other individuals in the cemetery, similar cranial features were seen. Many of the other adult individuals had shovel-shaped incisors, which is used as an indicator of Native American ancestry. The advanced age of the individual in burial feature seven resulted in teeth that were extremely worn, and it was not possible to determine if this individual also had shovel-shaped incisors. According to historical documents, many of the individuals buried in the St. Vital Cemetery were Métis (Colette Hopkins, personal communication 2003).

4.1.4 Pathologies or Abnormalities

This individual had a variety of pathological conditions. These will only be briefly mentioned here, but will be discussed in more detail in the corresponding chapters. Some of these conditions include the previously mentioned degenerative changes on the vertebrae. Also, on some of the dental occlusal surfaces, the enamel was worn off to the point of pulp cavity exposure. This individual also had carious lesions. One lesion in particular involved both the anterior ⅓ of the right third molar and the posterior ¼ of the right second molar in the mandibular dentition. Calculus was visible on the lingual side of the mandibular incisors and canines. A periapical abscess was noted on the alveolar mandibular region of the right canine. These conditions will be discussed further in chapter six.

Periostitis was discovered on the left proximal tibia. While it is often thought of as an indication of infection, there may have been other reasons as to the etiology. This will be discussed in chapter eleven.

The occipital region on the cranium was abnormally flat, suggesting that as an infant, she may have been carried around with the use of a cradleboard. This will be further discussed in chapter eight.

A bone sample was used to determine the concentrations of various chemical elements. This individual was found with a concentration of lead that while typical for the time, the level was high. This result will be discussed further in chapter nine.

4.2 Feature 10 Burial Description and Cultural Items

Grid location: 37N/6.5-7E

This burial feature was discovered through the testing of ground-penetrating radar anomalies. The coffin was in poor condition, but the intact skeletal remains of a female, aged 20 to 25 years at the time of death, were recovered. This individual was lying in an extended supine position with the arms crossed over the pelvis. The cultural materials associated with this burial included numerous seed beads, white glass buttons, two wooden matchsticks, brass beads on a leather cord, leather belt fragments, and a small, perforated shell found near the cranium.

4.2.1 Sex Estimation

This individual was determined to be female based on the Phenice technique, as described by White (2000:367). The pubic portions of the os coxae were analyzed for the presence of a ventral arc, subpubic concavity, and sharp medial aspect of the ischiopubic ramus. A preauricular sulcus was also present as well as a relatively wider sciatic notch. The cranium was also used in the determination of sex and, in this case, the individual had many characteristics of a female cranium, including small supraorbital ridges, small vault size and shape, as well as parietal bossing.

4.2.2 Age Estimation

Billowing on the dorsal surface of the pubic symphyses resulted in a recording of phase I, according to the Suchey-Brooks system (Suchey and Katz 1998). This places the age of the individual between 15 and 24 years. The Lovejoy et al. (1985) method was used on the auricular surfaces of the ilia, and they were assessed at phase II due to the fine granularity. Sternal rib surfaces also indicated that the individual was young. Very little wear was visible on the second and third molars from both the maxillary and mandibular dentitions. Some of the cranial sutures were fused, along with the spheno-occipital synchondrosis, which normally fuses between the ages of 20 and 25 according to Buikstra and Ubelaker's 1994 Standards volume (White 2000:351). The medial epiphyses on the clavicles were not fused, indicating a younger individual. Therefore, the estimated age at death for this female is 20 to 25 years.

4.2.4 Ancestry

The ancestry is assumed to be mixed, as many of the cranial indicators such as shovel-shaped incisors and canine fossae (Gill 1995) seem to be a combination of both a Caucasoid and Native American ancestry.

4.2.5 Pathologies and Abnormalities

This individual had no pathological conditions upon visual inspection other than a large amount of calculus on both the maxillary and mandibular dentitions. Also, the first cervical vertebra was not completely fused posteriorly. Spina bifida of the atlas is not an uncommon occurrence, and likely was asymptomatic (Scheuer and Black 2000:200).

4.3 Feature 11 Burial Description and Cultural Items

Grid location: 30N/29E

This burial feature, found through ground-penetrating radar, contained the skeletal remains of a young adult male, aged 20 to 24 years, in a wood coffin. The individual was lying in an extended supine position with the arms crossed on the pelvis. Numerous cultural items were recovered, including a vulcanized rubber comb, pocket-knife, wooden matches, brass religious medallion and cross, brass wire coils, one white glass button, shell buttons, many composite snap-closure buttons, and a white clay pipe.

4.3.1 Sex Estimation

While this individual had a striking amount of parietal bossing, which is normally a female indicator, the rest of the cranial and pelvic features indicated that this individual was a male. The pelvis, in particular, had male traits such as a relatively smaller subpubic angle, lack of a ventral arch and limited subpubic concavity. The cranium consisted of a sloped frontal area and larger supraorbital ridges.

4.3.2 Age Estimation

The age at death was estimated to be 20 to 24 years based on a number of factors. The pubic symphyses received a score of phase II according to the Suchey-Brooks scoring system (Suchey and Katz 1998), which placed the individual between the ages of 19 and 34 within a 95% confidence range. The auricular surfaces on the ilia still had a billowed appearance with fine granularity, similar to phase I in the Lovejoy et al. (1985) system. Minor dental wear could be seen on the maxillary third molars, and all of the cranial sutures were open. The spheno-occipital synchondrosis was fused, but lines of fusion were still visible on the distal radii and ulnae, which are areas that are normally fused by the age of 23.

4.3.3 Ancestry

Again, as with the previously mentioned individual, the indicators for ancestry showed a mixture of both Caucasoid and Native American backgrounds. Shovel-shaped incisors were present, but the amount of shovelling was limited. The trait scored a one on the Arizona State University Dental Anthropology System (Turner et al. 1991). The zygomatics were wide and projecting, which is a trait commonly seen in Native American populations, but the nasals were high and short, and the dentition was crowded. These features are seen more often in Caucasian populations.

4.3.4 Pathologies and Abnormalities

An assessment for pathological conditions revealed the presence of impacted mandibular third molars. Also, a small carious lesion was noted on the right maxillary first molar. Calculus was present on the lingual side of the mandibular incisors and on the buccal side of the maxillary molars. These dental conditions will be discussed in chapter six.

A bone sample was tested for the concentrations of trace chemical elements, and a high presence of lead was discovered. This will be discussed in chapter nine on metabolic disease and the presence of lead.

Lastly, this individual was found with separation of the lateral end of the acromial spine, which is an epiphysis of the scapula that did not fuse. It is theorized that this may be activity-related (Roberts and Manchester 1995:113). Further details can be found in chapter eight on traumatic conditions in the section on fractures that are related to occupation.

4.4 Feature 12 Burial Description and Cultural Items

Grid location: 47N/6E

This burial feature, located with ground-penetrating radar, contained the skeletal remains of a 25 to 30 year old male, found lying on his back in a semi-flexed position. The individual was not interred within a coffin. The cultural items recovered included a metal-backed mirror, a ferrous cup, a black fabric cap, a brass 'clip' found near the right side of the cranium, a leather fragment and three white glass buttons. Pupa casings were found within the vertebral column, suggesting that this individual had been deceased for some time prior to burial.

4.4.1 Sex Estimation

The cranial and pelvic features indicated that this individual was a male. The pelvis had a relatively smaller subpubic angle, smaller sciatic notch and shallow auricular area. The cranium consisted of a sloped frontal area and larger supraorbital ridges. The mastoids were large and the glabellar area was prominent.

4.4.2 Age Estimation

The pubic symphyses from this individual were fairly eroded, but enough was present to score the symphyses at phase III on the Suchey-Brooks scoring system (Suchey and Katz 1998), resulting in an age estimation of 30.7 ± 8.1 years. Other factors taken into account included the auricular surface, which according to the Lovejoy et al. (1985) method, was in phase II because of the fine granularity. The sternal rib ends had small areas with billowed surfaces indicating the individual's young age. Limited occlusal wear was noted on the third molars. The medial epiphyses on the clavicles were fused, and there were no other epiphyseal lines that could be seen on the other skeletal elements. All of these features indicate an age at death of 25 to 30 years.

4.4.3 Ancestry

The ancestry of this individual is estimated to be similar to the ancestry of the other individuals recovered from the St. Vital Cemetery. Historical records indicate that many Métis individuals were Catholic and may have been buried in the cemetery. Skeletal indicators found on this individual, such as robust, flaring zygomatics and shovel-shaped incisors suggest a Native American background, but the nasal profile and sill suggest a Caucasian background.

4.4.4 Pathologies and Abnormalities

This individual was also assessed for pathological conditions and abnormalities, and it was very interesting to discover that the right external auditory canal was missing. This is called aural atresia and will be further discussed in chapter seven on congenital conditions.

A bone sample was also removed from this individual to test for trace elements, and similar to the other adults recovered from the cemetery, this individual was found with a high level of lead. Further information on the lead analysis and results can be found in chapter nine.

An assessment of the dentition revealed two small carious lesions on the occlusal surfaces of the right maxillary premolar and the right third mandibular molar. Microdontia of the third molars was noted. The dimension of the left mandibular third molar was 7 mm x 8 mm, while the dimension of the second molar was 11 mm x 12 mm.

4.5 Feature 14 Burial Description and Cultural Items

Grid location: 37.5-39.5N/12-13E

The poorly preserved skeletal remains of a young male, aged 17 to 19 years at the time of death, lying in an extended supine position, was found through ground-penetrating radar. This individual had been buried in a wood coffin, and there was evidence that he had been covered with an animal hide. It is likely that this covering resulted in the poor preservation of the skeletal tissue. The cultural items associated with the burial included a white clay pipe, wooden matches, a wooden picture frame, tobacco, a leather belt with a ferrous buckle, and two strings of brass beads and coils.

4.5.1 Sex Estimation

The individual was assessed to be male based on the pelvic features such as a narrow subpubic angle and lack of a ventral arch. Also, a preauricular sulcus was not found and the greater sciatic notch was relatively narrow. Poor preservation of the cranium did not allow for a complete estimation of sex, but the supraorbital ridges were more pronounced, and the mastoids appeared to be fairly large.

4.5.2 Age Estimation

The age estimation of 17 to 19 years was based on the presence of a number of unfused epiphyses including the proximal humeri, the distal radii, and the distal femori. The average ages of fusion for these areas, as noted in Scheuer and Black (2000), are between the ages of 16 and 20 years for males. The pubic symphyseal area was estimated to be in phase I according to the Suchey-Brooks scoring system (Suchey and Katz 1998). The auricular surface was billowed, which placed it in phase I, based on the Lovejoy et al. (1985) research. The maxillary third molars had erupted, but they showed little to no wear. The right mandibular third was in the process of erupting prior to the individual's death.

4.5.3 Ancestry

This individual had shovel-shaped incisors, which leads to the assumption of some Native American ancestry. Due to the poor preservation of the cranium, it was difficult to assess any other indicators of population affinity.

4.5.4 Pathologies and Abnormalities

This individual was not found with any pathological conditions other than spondylolysis of the fifth lumbar vertebra. It is questionable as to whether this condition was developmental or the result of an inherited condition. Further details on spondylolysis can be found in chapter eight.

4.6 Feature 15 Burial Description and Cultural Items

Grid location: 38-40N/8-9E

This burial feature, located through ground-penetrating radar, contained the skeletal remains of a young male, aged 18 to 20 years at the time of death. The individual was found in a wood coffin, lying in an extended supine position with the hands crossed on the pelvis. The associated cultural items included glass buttons, seed beads, and a ferrous overalls buckle.

4.6.1 Sex Estimation

According to the Phenice method, which uses the pubic portion of the os coxae (White 2000:367), this individual was male based on the lack of a ventral arc and subpubic concavity. The auricular surface was also quite shallow. The cranial male indicators included a sloped frontal area, large supraorbital ridges, and large mastoids.

4.6.2 Age Estimation

The age estimation of 18 to 20 years was based on the number of unfused epiphyses such as the proximal humeri, distal radii, and the proximal and distal femori. The pubic symphyses were too eroded to be assessed. The sternal rib surfaces were billowed with slight indentations. Dental wear was very slight on both the maxillary and mandibular third molars.

4.6.3 Ancestry

This individual was found to have shovel-shaped incisors, an indicator of possible Native American ancestry. The zygomatic bones were relatively wide and tubercles were present. Some Caucasoid features were also noted, including a projecting chin and a moderate nasal spine.

4.6.4 Pathologies and Abnormalities

Periostitis was noted on the second lumbar vertebra. This condition will be further discussed in chapter eleven on infectious disease. Caries were not visible on the dentition, but calculus was evident on the lingual surface of the mandibular canines, as well as the buccal surface of the right maxillary second molar. An unusual developmental feature was found on the thoracic vertebrae. The right inferior articular process on the eleventh thoracic vertebra and the right superior articular process on the twelfth vertebra were separate from the corresponding vertebrae.

4.7 Feature 17 Burial Description and Cultural Items

Grid location: 40-42N/26-28E

This burial feature, found through ground-penetrating radar, contained the skeletal remains of a 30 to 40 year old male, lying in an extended supine position with the hands crossed on the pelvis. The individual was interred in a tapered coffin, which was placed within a larger rectangular box. The associated cultural items included a ferrous overalls buckle, shell and glass buttons, and composite snap-closure buttons. A right mandible from a northern pocket gopher (*Thomomys talpoides*) was found suggesting rodent disturbance of the burial.

4.7.1 Sex Estimation

This individual was assessed to be male based on a number of factors. The pelvic area was found to have a small subpubic angle, with no ventral arch, preauricular sulcus or parturition pits. A number of features on the cranium also indicated the individual was likely male. The mastoids and supraorbital ridges were relatively large, and the overall size of the cranial vault was larger in comparison to all of the other individuals recovered from the St. Vital Cemetery.

4.7.2 Age Estimation

The age at death was estimated to be 30 to 40 years for this individual. According to the Suchey-Brooks system of scoring pubic symphyses (Suchey and Katz 1998), this individual was scored as phase V, which leads to an estimated age of 34.7 ± 7.8 years. The auricular surface showed indications of coarse granularity, placing it in phase 4 in the Lovejoy et al. (1985) system. The sternal rib surface was noted to be deep and irregular. Heavier dental wear was seen on the first molars, but less wear was found on the second and third mandibular and maxillary molars. Degenerative changes were seen on the lumbar vertebrae. All of these indicators led to the estimation that the individual was in his thirties at the time of death.

4.7.3 Ancestry

As the cranial features on this individual were very similar to the other individuals, the assumption is made that this individual may have had a similar ancestral background. It was not possible to identify shovel-shaped incisors, as they had considerable wear. There was very little facial prognathism, and moderate canine fossae were evident.

4.7.4 Pathologies and Abnormalities

This individual had evidence of very few pathological conditions. Osteophytic lipping, an indicator of a degenerative condition was visible on the second through fourth lumbar vertebrae. This will be discussed further in chapter ten. Extensive calculus deposits were seen on both the buccal and labial surfaces of the mandibular and maxillary dentitions. Carious lesions were noted on the occlusal surfaces of the left maxillary second molar and the left mandibular second molar.

4.8 Feature 18 Burial Description and Cultural Items

Grid location: 41-42.5N/2.5-4E

This burial feature, discovered through ground-penetrating radar, contained the skeletal remains of a 30 to 35 year old female, lying in an extended supine position with the hands crossed on the pelvis. This individual was located within a wood coffin, which had preserved although the lid was heavily damaged due to the soil pressure. A rosary, consisting of a brass cross and wooden beads, was found between the femora. Three brass medallions were also recovered.

4.8.1 Sex Estimation

This individual was assessed to be female based on pelvic features such as a wide subpubic angle and the presence of both a ventral arch and a preauricular sulcus. The greater sciatic notch was relatively wide, and the auricular area was noted to be deep. The cranium was gracile with a vertical frontal area, and parietal bossing was present.

4.8.2 Age Estimation

The age at death was estimated to be between 30 and 35. The pubic symphyses, according to the Suchey-Brooks scoring system (Suchey and Katz 1998), were in phase III, indicating a potential age of 30.7 ± 8.1 years. The auricular surfaces had reduced amounts of billowing with striae starting to appear. Sternal rib surfaces had irregular rim contours. Dental wear was significant on the mandibular and maxillary second molars. The third molars were congenitally absent.

4.8.3 Ancestry

Shovel-shaped incisors were present, indicating possible Native American ancestry. The zygomatic bones had limited projection, and the nasal spine was pronounced. These features are indicative of a Caucasoid ancestry.

4.8.4 Pathologies and Abnormalities

Visible pathological conditions were not evident on this individual, with the exception of calculus deposits on the lingual surfaces of the mandibular premolars.

4.9 Feature 23 Burial Description and Cultural Items

Grid location: 34N/11E

This burial feature was found during mechanical stripping of the site. Once wood fragments were seen, the area was tested, and a coffin was discovered to contain the skeletal remains of a 20 to 25 year old female. There were no cultural items recovered from this burial.

4.9.1 Sex Estimation

This individual was assessed to be female based on pelvic evidence, including the presence of a wide subpubic angle, a preauricular sulcus, a wide greater sciatic notch, and a deep auricular area. Scars of parturition were evident on the right pubic bone. Many of the cranial features were small, including the mastoids and supraorbital ridges. Parietal bossing was evident.

4.9.2 Age Estimation

The estimated age at death of 20 to 25 years was based on a number of factors including the pubic symphyses. According to the Suchey-Brooks system (Suchey and

Katz 1998), this individual was assessed as phase II, placing the age of the individual at 25 ± 4.9 years. The auricular surfaces still had evidence of billowing, which is a feature seen in young individuals. The sternal rib ends also had remnants of a billowed surface. Minor dental wear was evident on the maxillary and mandibular first and second molars. The third molars had no evidence of wear. Analysis of epiphyseal closure revealed that most were fused except for the epiphyses on the medial clavicles.

4.9.3 Ancestry

The ancestry is estimated to be a combination of both Native American and Caucasian backgrounds. Shovel-shaped incisors were noted although the shovelling was very slight. Alveolar prognathism was evident, and the zygomatic bones moderately projected.

4.9.4 Pathologies and Abnormalities

Spondylolysis was noted involving the fourth lumbar vertebra. This condition, which is a failure of a vertebral arch to fuse, will be further discussed in the chapter eight. Osteochondritis dissecans was found bilaterally on the proximal surfaces of the third metatarsals and distal surfaces of the lateral cuneiforms. Further details on this condition can be found in chapter ten. Calculus was evident on the lingual surfaces of the right mandibular premolars. A carious lesion was discovered on the left mandibular first premolar.

4.10 Feature 24 Burial Descriptions and Cultural Items

Grid location: 44N/14E

This burial feature was discovered during the mechanical stripping of the site with a front-end loader. A wood coffin with skeletal remains was uncovered, but in the process some damage occurred to both the coffin and the cranial portion of the individual. The individual, who was lying in an extended supine position with the hands crossed on the pelvis, was assessed to be a male, aged 30 to 34 years at the time of death. The cultural items found with this burial included an overalls buckle, glass buttons, metal buttons, four brass religious medallions, and a piece of silk that was found wrapped around the feet.

4.10.1 Sex Estimation

The sex estimation of the individual was based on the pelvic morphology, as well as some of the features that could still be seen on the fragmented cranium. The pelvic subpubic angle was relatively small, a subpubic concavity was not present, and the mastoids on the cranial temporal bones were fairly large, which leads to the assessment that the individual was male.

4.10.2 Age Estimation

The estimated age of 30 to 34 years is based on factors such as the morphology of the pubic symphyses, which were similar to the phase III Suchey-Brooks description

(Suchey and Katz 1998), resulting in an age range of 30.7 ± 8.1 years. The auricular surfaces had the appearance of striae with a loss of billowing, suggesting a phase III stage (Lovejoy et al. 1985). The sternal rib surface was deep with an irregular rim contour. Dental wear could not be assessed due to the poor condition of the teeth as a result of many caries. All epiphyses were fused. The cranium, which was damaged as a result of the mechanical stripping, fragmented along open suture lines.

4.10.3 Ancestry

It was difficult to estimate the ancestry of this individual due to the incomplete nature of the cranium as a result of postmortem damage. The small number of incisors that were recovered exhibited only minor shovel-shape development.

4.10.4 Pathologies and Abnormalities

A few pathological conditions and abnormalities were observed on this individual's remains. The right fifth metacarpal had evidence of a healed fracture. Further information on fractures will be discussed in chapter eight. Enamel hypoplasia, an indicator of disease or dietary deficiencies, was clearly evident in the dentition. Large carious lesions were seen on the right mandibular second molar and first premolar. The upper dentition consisted of only fragments of the incisors and premolars. These conditions will be discussed further in chapter six. Lastly, the medial portion of the right navicular was not fused.

4.11 Feature 28 Burial Description and Cultural Items

Grid location: 46N/7E

This burial feature was located during the final process of mechanically stripping the site. A damaged wood coffin with the skeletal remains of a female, aged 25 to 30 years, was found. The damage did not occur during the stripping process and must have occurred at an earlier time. Part of the surface scatter collection from the original assessment of the site in 2000 was matched with the fragmented cranial bones recovered in the full excavation of the burial feature. Brass ball buttons, a shell button, glass buttons, and fragments of an unidentified ferrous artifact were found with the individual.

4.11.1 Sex Estimation

Both the pelvis and the cranium were fragmented, but it was estimated that the individual was a female based on bone landmarks that were still intact. The greater sciatic notches were wide, and a preauricular sulcus was noted. The frontal portion of the cranium appeared to be vertical, and the overall size of the vault was small, including the mastoids and supraorbital ridges.

4.11.2 Age Estimation

The age estimation of 25 to 30 years was based on the appearance of billowing on the auricular surfaces, and significant dental wear was found on the first and second maxillary and mandibular molars. Some minor osteophytes were evident on the fifth lumbar vertebra. The pubic symphyses were too eroded to be part of the analysis, and while the cranium was fragmented, it was noted that the cranial sutures were only partially fused.

4.11.3 Ancestry

The individual was found to have shovel-shaped incisors, and the overall morphology of the cranium was very similar to the other individuals recovered from the cemetery. This suggests a similar ancestral background of mixed Native American and Caucasian.

4.11.4 Pathologies and Abnormalities

A number of interesting pathological conditions were found associated with this individual. Periostitis, the formation of new bone due to infection or other processes, was located on the lingual surface of the right side of the mandible, as well as the inferior surface of a left rib. This individual had evidence of enamel hypoplasia, and supernumerary teeth were present in the maxillary region. Calculus was noted on the labial surfaces of the left mandibular canine, first premolar, and second premolar. Incipient caries were found on the occlusal surfaces of the right maxillary third molar and left first molar. These dental conditions will be discussed further in chapter six.

TABLE 4-1
Summary of Skeletal Information (Adults)

Feature #	Sex	Age	Pathological Conditions and Abnormalities
7	F	60+	cranial deformation lead concentration- 190ppm periostitis on left tibia attrition, caries, calculus degenerative joint disease
10	F	20-25	spina bifida of the atlas lead concentration– 89ppm calculus
11	M	20-24	impacted mandibular third molars caries, calculus lead concentration– 200ppm os acromiale
12	M	25-30	aural atresia lead concentration– 203ppm caries
14	M	17-19	spondylolysis – L5
15	M	18-20	periostitis on L2 T11/T12 – facet separate calculus
17	M	30-40	osteophytes L2-L4 caries, calculus
18	F	30-35	lead concentration – 32ppm calculus
23	F	20-25	spondylolysis – L4 osteochondritis dissecans (3rd metatarsals and lateral cuneiforms) calculus, caries
24	M	30-34	healed fracture (right 5th metacarpal) enamel hypoplasia caries lead concentration – 75ppm medial navicular not fused (right)
28	F	25-30	periostitis – mandible and left rib supernumerary incisors (maxillary) enamel hypoplasia incipient caries, calculus

CHAPTER FIVE: Infant and Juvenile Skeletal Remains

A table containing the summary of the infant and juvenile skeletal information is located at the end of this chapter (Table 5-1).

5.1 Feature 2 Burial Description

Grid Location: 35N/9E

Intact infant remains were recovered encased in a mass of undetermined material that may have been moss (Colette Hopkins, personal communication 2003). The circular wrapping disintegrated upon excavation. The infant had been placed on his or her left side, and the lower limb elements were in a position that suggested the knees were flexed. There was no preserved fabric found with the burial. The age at death was determined to be 32 ± 2 fetal weeks based on femoral length.

5.1.1 Skeletal Inventory

Cranial

The cranium was fragmented due to the infant's young age.
The occipital consisted of the pars squama, right and left pars lateralis and pars basilaris.
Frontal – left and right
Temporal – tympanic rings separate, pars petrosa (length – 31 mm and width – 14 mm)
Maxilla – left and right, fragmented and incomplete
Sphenoid – fragmented
Mandible – fragmented (left and right halves)

- symphyseal height – 9 mm
- body length – approximately 40 mm
- ramus height – 14 mm
- body height – 7 mm
- maximum ramus breadth – 12 mm

Postcranial

Scapula –	right -	present
	left -	fragmented
Clavicle –	right -	fragmented and incomplete
	left -	length – 36 mm
		maximum midshaft diameter – 3 mm
Humerus-	right -	maximum length – 52 mm
		maximum midshaft diameter – 4 mm
		biepicondylar width – 11 mm
	left -	present
Radius-	right -	maximum length – 42 mm
	left -	present
Ulna-	right -	maximum length – 48 mm
	left -	present
Innominate	right -	present
	left -	missing
Femur	right -	maximum length – 57 mm
	left -	incomplete
Tibia	right -	fragmented and incomplete
	left -	maximum length – 51 mm
Fibula	right -	fragmented and incomplete
	left -	fragmented and incomplete

Patella-n/a
Sternum-n/a
Ribs – 9 left, 10 right (4 rib fragments)
Teeth –maxilla – $^{2}i, ^{1}i, i^{1}, m^{1}$
mandible – $_{1}m, _{2}i, i_{2}$
plus 11 unidentified crowns

Vertebrae –	25 vertebral centrae
	48 posterior arch halves plus dens (length 6 mm)
Sacrum –	maximum anterior height – 26 mm
	maximum anterior breadth – 21 mm

5.1.2 Pathologies and Abnormalities

Lead analysis revealed a lead concentration of 60 ppm. This is unusually high for a preterm infant, but studies have shown that lead ingested or inhaled by the mother can be passed on to the infant through the placenta (Warren 2000:16).

5.2 Feature 4 Burial Description

Grid location: 32.5N/18E

This feature was a disturbed burial, found close to the surface, consisting of many bone and wood fragments. It was possible to match the skeletal remains with some of the other excavated burial features, as well as separate the unmatched elements into different age categories. These data can be found in Appendix B, which is a listing of the skeletal elements found on the surface grouped according to estimated age. Otherwise, the remaining skeletal remains associated with feature 4 were two tibiae with a maximum length of 195 mm. These elements may have belonged to a child approximately four years of age. No cultural items were recovered with this burial.

5.3 Feature 5 Burial Description

Grid location: 37-38N/27-28E

This burial feature consisted of two small coffins and a lid (Colette Hopkins, personal communication 2003). The boxes were found empty with the exception of an infant femur with a maximum length of 55 mm. It is estimated that the bone belonged to a pre-term infant of 32 fetal weeks.

5.4 Feature 8 Burial Description

Grid location: 48.5N/10E

Through the use of GPR technology, a rectangular coffin with compressed side walls was uncovered, containing the skeletal remains of a 10 to 12 year old juvenile of unknown sex. Many skeletal elements in the thoracic region were disturbed and out of position, including two cervical vertebrae that were found superior to the cranium. No evidence of rodent activity was found. The age estimate was based on the many unfused epiphyses, lack of wear on the maxillary second molars, flat sternal rib surface, subadult appearance of the auricular surfaces and the billowed surfaces on the pubic symphyses. As for population affinity, there were indications of possible Native American ancestry, since the incisors had a shovelled-shape appearance. Complete inventory data are located in Appendix A.

5.4.1 Pathologies and Abnormalities

Lead analysis revealed a lead concentration of 142 ppm.

5.5 Feature 13 Burial Description

Grid location: 44.5N/4.5E

Dr. E. Walker, from the Department of Archaeology at the University of Saskatchewan, excavated this burial feature during the initial investigation. The skeletal remains were not interred in a coffin. The remains were flexed, and the individual had been placed on his or her right side. The age at death is estimated to be nine years. No cranial elements were located. Cultural materials were not found to be associated with this burial feature.

5.5.1 Skeletal Inventory

Postcranial

Scapula –	right -	present	
	left -	fragmented and incomplete	
Clavicle -	right -	present	
	left -	present	maximum length 110 mm
Humerus -	right -	incomplete (missing proximal epiphysis)	
	left -	present	maximum length 240 mm
			maximum midshaft diameter 15 mm
			biepicondylar width 39 mm
Radius -	right -	present	maximum length 180 mm
	left -	fragmented and incomplete	
Ulna -	right -	present	maximum length 193 mm
	left -	fragmented and incomplete	
Innominates -	right and left – present (still 3 components)		
		iliac breadth 99 mm	
		sciatic notch width 28 mm	
Femur -	right and left – present (epiphyses not fused)		
		maximum length 329 mm	
		femoral circumference 67 mm	
Tibia -	right and left – present		
		maximum length 270 mm	
Patella -	right and left – present		
Fibula -	right – fragmented and incomplete		
	left – fragmented and incomplete		

Ribs – left-8, right-7, fragments-14

All tarsals and metatarsals were recovered.

The right first metatarsal had a fused proximal epiphyses.

Talus	maximum length 50 mm
	maximum width 32 mm
	body height 27 mm
Calcaneus	maximum length 62 mm
	anterior breadth 32 mm
	minimum body height 31 mm

Only the right and left first metacarpals, second left metacarpal and third left metacarpal were recovered.

Phalanges – 3

Vertebrae – cervical vertebrae (6 recovered but in poor condition)
thoracic – 12 (arches fused)
lumbar – 5
sacral – 5 (not fused)

5.5.2 Pathologies and Abnormalities

Harris lines were detected on the radiograph of the tibiae indicating arrested growth and development. Periostitis was identified on the left third and fourth metacarpals.

5.6 Feature 19 Burial Description

Grid location: 38-39.5N/6.5E

This burial feature was an infant aged between 1.5 and 2 years. The child was discovered while excavating burial feature 15. Poor preservation resulted in porous and fragmented skeletal material. Cultural items included white glass buttons.

5.6.1 Skeletal Inventory

The cranium was fragmented and incomplete.
Occipital – pars basilaris (width – 23 mm)
pars lateralis (width – 21 mm and length – 39 mm)
Frontal – fragmented and incomplete
Mandible – missing right coronoid and condyle
symphyseal height – 21 mm
body length – 67 mm
ramus height – 33 mm
body height – 19 mm
maximum ramus breadth – 28 mm
minimum ramus breadth – 25 mm
gonial angle – 138°

Many postcranial elements were recovered, but they were also fragmented and incomplete.

Clavicle - maximum length 73 mm

Humerus - maximum length 125 mm
maximum midshaft diameter 11 mm
biepicondylar width 24 mm
Ulna - maximum length 106 mm
Radius - maximum length 97 mm
Innominate – iliac breadth 59 mm
maximum length 58 mm
sciatic notch width 15 mm
Tibia - maximum length 135 mm
Fibula - maximum length 131 mm
Femur (right) -maximum length 157 mm
Ribs – 5 left and 1 right and 27 fragmented pieces
Sternum – manubrium (23 mm x 19 mm) sternabrae (total of 3 –13 mm x 13 mm, 13 mm x 13 mm and 8 mm x 6 mm)
Calcaneus – right and left present (25 mm)
Talus – right and left present (23 mm)
Metatarsals – 9
Teeth – permanent mandibular and maxillary molars could be seen in crypt (12 mm x 11 mm)
All deciduous teeth were accounted for.
Vertebrae – 26 centrae, 34 vertebral fragments
os dens – 16 mm x 9 mm
Sacrum – lateral elements separate

5.6.2 Pathologies and Abnormalities

Harris lines, indicating arrested growth and development, were detected on the radiograph of the tibiae.

5.7 Feature 20 Burial Description

Grid location: 34N/2E

This burial feature was initially found through GPR. It consisted of a small coffin that contained the skeletal remains of a child between the ages of 2 and 2.5 years, lying in an extended supine position. Preserved hair was recovered. The cultural item associated with this burial feature was a brass religious medallion.

5.7.1 Skeletal Inventory

The cranium was nearly complete with bone fragmentation found only on the left temporal, left zygomatic and mandible.

pars lateralis – 35 mm x 28 mm
pars basilaris – 20 mm x 26 mm

Mandible - symphyseal height – 23 mm
body length – 85 mm
ramus height – 37 mm
bigonial breadth – 64 mm
body height – 22 mm
body thickness – 11 mm
maximum ramus breadth – 30 mm
minimum ramus breadth – 25 mm
gonial angle – 138 mm

More cranial measurements can be found in Appendix A.
Both right and left scapulae were fragmented and incomplete.
Both right (76 mm) and left clavicles were present, but the left was incomplete.
The left radius was fragmented and incomplete (112 mm)
Both right and left innominates were fragmented and incomplete.
Femur – right and left present (194 mm)
Tibia – right and left present (157 mm)
Fibula – right and left present (155 mm)
Sternum – manubrium (22 mm x 25 mm)
3 sternabrae
Ribs – left – 4
right – 6
27 rib fragments
Calcaneus – right and left present (35 mm)
Talus – right and left present (28 mm)
9 metatarsals
5 metacarpals
16 phalanges
Teeth – permanent first molar crowns visible in crypt
All deciduous teeth present and erupted.
Vertebrae – 7 cervical present
29 vertebral fragments
18 centra
os dens – 19 mm x 12 mm
anterior bar on atlas not fused
thoracic, lumbar and sacral vertebrae not fused

5.7.2 Pathologies and Abnormalities

Harris lines indicative of arrested growth and development were detected on the radiograph of the tibiae.

5.8 Feature 21 Burial Description

Grid location: 30.5N/17.5E

Mechanical stripping of the site resulted in the location of this burial feature. Part of a coffin and a small number of skeletal fragments were discovered. It is uncertain as to whether the coffin destruction was from the backhoe used for mechanical stripping or from the original levelling of the site. This was an infant aged approximately two months at the time of death based on femoral length. No cultural items were recovered with this burial.

5.8.1 Skeletal Inventory

The only cranial elements belonged to part of a left temporal – the tympanic ring and pars petrosa.

Femur –	right (91 mm)
	left (fragmented and incomplete)
Tibia -	right (fragmented and incomplete)

5.9 Feature 22 Burial Description

Grid location: 34N/18E

This burial feature consisted of an infant coffin found through mechanical stripping. The coffin contained the skeletal remains of an infant aged approximately six months, lying in an extended supine position.

5.9.1 Skeletal Inventory

Cranial

The majority of the cranium was fragmented and incomplete.

Occipital –	pars lateralis (2)	
	pars basilaris (16 mm x 21 mm)	
Frontal		
Parietals		
Sphenoid		
Temporals		
Zygomatics –	right and left – complete	
Maxilla –	right and left – complete	
Mandible –	complete	

Postcranial

Scapula –	both right and left fragmented and incomplete	
Clavicle –	right and left – present	maximum length – 56 mm
Humerus –	right and left – present	maximum length – 97 mm
		maximum midshaft diameter – 10 mm
	plus proximal epiphyses	
Radius –	right and left – present	maximum length – 80 mm
Ulna –	right and left – present	maximum length – 87 mm
Innominate –	right and left – present and each in 3 parts	
	ilium – 52 mm wide and 37 mm high (from sciatic notch)	
Femur –	right and left – present	maximum length – 119 mm
	plus proximal epiphyses	
Tibia –	right and left – present	maximum length – 103 mm
	plus proximal epiphyses (21 mm x 14 mm)	
Fibula –	right and left present	
Sternum –	manubrium (14 mm wide)	
	sternabra	

Ribs – left – 11
right - 12
Calcaneus – right and left present (21 mm)
Talus – right and left present (16 mm)
All metatarsals were present and identifiable.
Metacarpal 1 – right and left present
Metacarpals – 6 recognizable but not identifiable to number.
Phalanges – 21
Teeth – All maxillary and mandibular deciduous crowns were visible. The first mandibular incisors appeared to be in the process of eruption at the time of death.
Vertebrae – cervical – 6 centrae, other – 22 centrae
os dens – 14 mm x 9 mm
posterior arch halves – 12
posterior complete arches – 14
atlas bar

5.10 Feature 26 Burial Description

Grid Location: 34.5N/5E

This burial feature was exposed during the final process of mechanically stripping the site. It was heavily disturbed by the front-end loader, and very few skeletal and cultural remains were found. The age at death is estimated to be two months based on tibial length. Cultural items recovered with this burial feature included an unidentified brass artifact and remnants of a small colourless glass vial.

5.10.1 Skeletal Inventory

Cranial

Frontal - fragmented and incomplete.
Zygomatic – left – fragmented and incomplete

Postcranial

tibiae – right and left – present maximum length – 79 mm

5.11 Feature 27 Burial Description

Grid location: 41N/4E

This burial feature was found intact during mechanical stripping. A small coffin was recovered, and interestingly, the original pit outline was still visible due to the contrasting soil colour. The age at death for this neonate was estimated to be 38 fetal weeks ± 2 weeks. No cultural items were recovered with this burial.

5.11.1 Skeletal Inventory

Cranial

This infant was found intact, but due poor preservation, a number of the skeletal elements were fragmented and incomplete.

Occipital –	pars lateralis (2) (19 mm x 11 mm)
	pars basilaris (12 mm x 14 mm)
Frontal –	fragmented and incomplete
Parietal –	right and left present (left had traces of hair)
Temporal –	right – present, left – fragmented and incomplete
Zygomatic –	right – present, left – fragmented and incomplete
Maxilla –	right – present, left – fragmented and incomplete
Sphenoid –	right and left present
	lesser wings and presphenoid attached
	span of lesser wings – 34 mm
	greater wing width – 28 mm
Mandible –	present and unfused (2 parts)

Postcranial

Scapula –	right –	fragmented and incomplete	
Clavicle –	right		maximum length 41 mm
	left –	fragmented and incomplete	
Humerus –	right and left – present		maximum length 66 mm
Radius –	right and left – present		maximum length 52 mm
Ulna –	right –	present	maximum length 59 mm
	left –	fragmented and incomplete	
Innominates –	fragmented and incomplete		
		ilia – 22 mm x 28 mm	
		ischium – left – length 16 mm	
Femur –	right -	present	maximum length 74 mm
	left –	fragmented and incomplete	

Tibia -	right -	present	maximum length 62 mm
	left –	fragmented and incomplete	

Metacarpals – 7
Metatarsals – 6
Phalanges – 10 (1 phalanx with nail still present)
Ribs – fragments – 32, 12 rib ends and 7 rib heads
Teeth – All deciduous teeth were visible in the crypts, but crowns were very small and there was no sign of any eruption activity.
Vertebrae – 20 vertebral bodies, 32 posterior arch halves

5.12 Feature 29 Burial Description

Grid location: 49N/3E

This burial feature was revealed through mechanical stripping. A small wood coffin was removed intact and contained the skeletal remains of an infant, approximately one year of age. Cultural items associated with this burial were white glass buttons.

5.12.1 Skeletal Inventory

Cranial

The cranium was fragmented and incomplete.

Frontal –	metopic suture almost completely fused
Occipital –	pars lateralis (2) (32 mm x 20 mm)
	pars basilaris (16 mm x 19 mm)
Parietals –	right and left – fragmented and incomplete
Temporals –	right – fragmented and incomplete
	left – present (length of petrous temporal 19 mm)
	malleus – 1
	incus - 1
Zygomatic -	right – fragmented and incomplete
	left – present (32 mm x 25 mm)
Maxilla -	right and left – present
Sphenoid –	fragmented and incomplete (presphenoid and postsphenoid fused)
	width of left greater wing 41 mm, length 24 mm

Postcranial

Scapula –	right and left – fragmented and incomplete	
Clavicle –	right and left – present	maximum length 58 mm
Humerus –	right and left – present	maximum length 93 mm

Radius –	right and left – present	maximum length 75 mm
Ulna –	right – present	maximum length 84 mm
	left – fragmented and incomplete	
Innominates –	right and left ilia identifiable	
	iliac breadth 44 mm	
	sciatic notch width 11 mm	
Femur –	right and left – fragmented and incomplete (approximately 112 mm)	
Tibia –	right and left – fragmented and incomplete (approximately 93 mm)	
Fibula –	left - fragmented	
Sternum -	manubrium (18 mm x 14 mm)	
	sternebrae (13 mm x 12 mm and 11 mm x 11 mm)	

Ribs – left – 12, right – 12
Calcaneus – 1 recognizable but unidentifiable for side (maximum length 15 mm)
Talus - 1 recognizable but unidentifiable for side (maximum length 13 mm)
Metatarsals – 8
Metacarpals – 9
Phalanges - 3
Teeth – All deciduous teeth, expect for the right maxillary incisors, were accounted for. All teeth had erupted except for the deciduous second molars. The maxillary and mandibular crowns of the permanent first molars were visible in their crypts.

Vertebrae –	24 centrae (largest 13 mm x 19 mm, smallest 7 mm x 8 mm)
	os dens – 6 mm x 12 mm
	posterior arches – 14
	arch halves – 20

5.13 Feature 30 Burial Description

Grid location: 45.5N/8.5E

This burial feature was found through means of mechanical stripping and was intact and undisturbed. It consisted of a small coffin with the poorly preserved skeletal remains of a neonate aged 40 fetal weeks. No cultural materials were recovered.

5.13.1 Skeletal Inventory

Cranial

All cranial elements were fragmented and incomplete.

Postcranial

Most postcranial elements were fragmented and incomplete.

Humerus –	right – fragmented and incomplete
	left – present (maximum length 70 mm)
Radius -	right – present (maximum length 55 mm)
	left – present
Ulna -	right – fragmented and incomplete (approximately 59 mm)
	left – fragmented and incomplete
Innominate -	right and left – present (ilium, ischium and pubis)
	iliac breadth – 37 mm
	maximum length – 33 mm
	sciatic notch width – 6 mm
Femur -	right – fragmented and incomplete
	left – present (maximum length 83 mm)
Tibia -	right and left – present (maximum length 70.5 mm)
Fibula -	right and left – fragmented and incomplete
	maximum length approximately 63 mm

Ribs – fragments – 34
Metatarsals – 8
Metacarpals – 6
Phalanges – 15
Teeth – 10 incisor/canine crowns, 7 molar crowns

Vertebrae –	centrae – 23 (most in poor shape)
	posterior arches – 3
	posterior arch halves – 41

TABLE 5-1
Summary of Skeletal Information (Juveniles and Infants)

Feature #	Age Estimate	Pathological Conditions and Abnormalities
2	32 fetal weeks	Lead concentration- 60ppm
4	4 years	
8	10-12 years	Lead concentration- 142ppm
13	9 years	periostitis – left 3^{rd} and 4^{th} metacarpals Harris lines
19	1.5-2 years	Harris lines
20	2-2.5 years	Harris lines
21	2 months	
22	6 months	
26	2 months	
27	38 fetal weeks ± 2 weeks	
29	1 year	
30	40 fetal weeks ± 2 weeks	
Skeletal remains identified from the surface scatter (See Appendix B)		
SS1	5 years	enamel hypoplasia
SS2	3 years	
SS3	12-15 years	right mesially rotated second premolar
SS4	40 weeks	
SS5	3 months	thickened left tibia
SS6	32 fetal weeks	
SS7	2 years	

CHAPTER SIX: Dental Pathological Conditions and Abnormalities

The study of an individual's dentition allows for the opportunity to gain considerable information about that particular individual. Teeth can often give an indication about the individual's diet, oral hygiene, stress, and cultural behaviour (Roberts and Manchester 1995:44). Teeth are usually the last skeletal component to degrade because tooth enamel is an extremely hard substance that results in good preservation. Enamel will not preserve as well in acidic soil conditions or when the method of cremation is used, as it results in the enamel flaking away from the dentine (Hillson 1996:181).

Pathological dental conditions are often not in isolation because one area will impact the other. For example, calculus deposits will result in a higher likelihood of gingivitis, which leads to the reduction of alveolar bone and tooth loss (Roberts and Manchester 1995:44).

6.1 Impacted Molars

Impacted molars are a very common occurrence in the modern population. In one study, over 72% of Swedish individuals between the ages of twenty and thirty had at least one impacted third molar (Worrall 2002). These molars, often referred to as 'wisdom teeth' because of their late eruption time (late teens to early twenties), are regularly extracted due to dental crowding.

Severely impacted mandibular third molars were discovered in the dentition of the individual from burial feature 11. Molar impaction types include vertical, mesioangular, distoangular and horizontal (Azaz et al. 1976). In this instance, the impaction seen in the individual from burial feature 11 is almost completely horizontal (Fig. 6-1). It has been suggested that the appearance of impacted wisdom teeth in the population is the result of increased dental hygiene, which results in the likelihood that all permanent teeth will be retained into adulthood, leaving less space for the third molars (Worrall 2002).

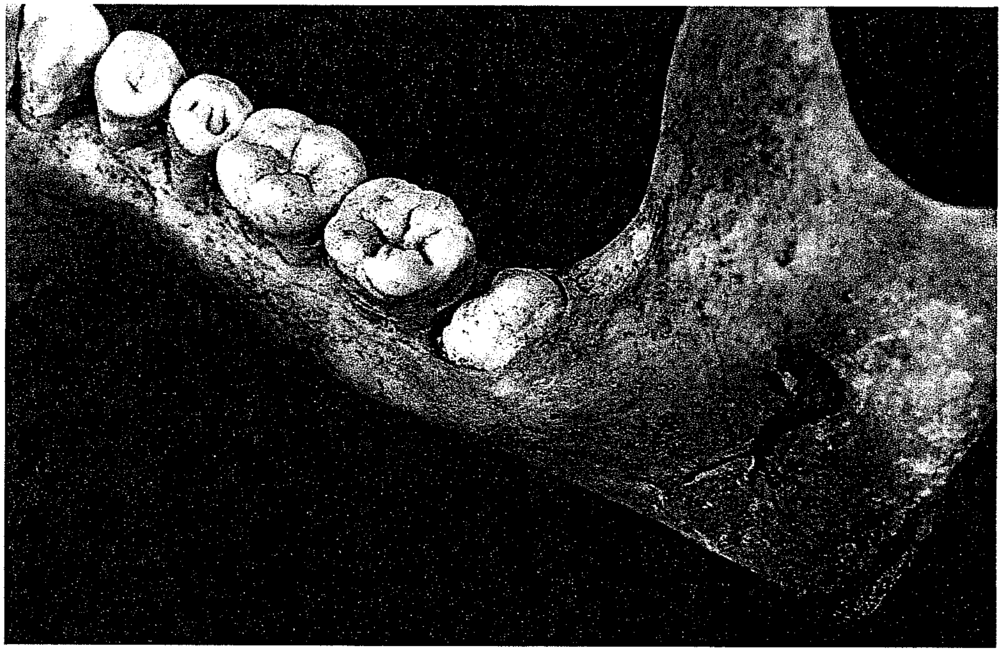

Figure 6-1: Impacted third molar in the dentition from the individual in burial feature 11.

6.2 Caries

A common dental condition found in all populations is caries (Latin for 'rottenness'), due to the process of infectious disease (Roberts and Manchester 1995:45). A carious lesion has an irregular border, is often discoloured, and necrotic dentine is found at the lesion (Turner et al. 1991). Food sugars are fermented on the teeth by bacteria such as *Lactobacillus acidophilus* and *Streptococcus mutans*, resulting in caries if proper hygiene is not used. The teeth will become demineralized if the sugar-fermenting bacteria produce enough acid, and eventually a cavity will form. By the end of the 19th century, the consumption of sugar varied, but in some populations, the rate was calculated to be 20 pounds per person per year. By the turn of the century the amount increased to 90 pounds per person per year, if the individuals had access to items such as chocolate and jam (Roberts and Manchester 1995:50).

Many factors are involved with the prevalence of caries in an individual. One significant factor is a high sugar diet, but other factors such as tooth morphology can have an influence on whether a cavity will form or not. In fact, Roberts and Manchester (1995:46) report on a study where there was little correlation between the amount of sugar in the diet and the number of caries.

Environmental factors, such as the presence of certain trace elements, will play a role in whether an individual is more predisposed to developing caries (Roberts and Manchester 1995:46). There is a correlation between the amount of fluoride in the drinking water and the number of caries an individual may have. Higher fluoride levels lessen the chance of acquiring caries, but fluoride levels that are too high lead to the condition of fluorosis, which has an impact on the integrity of the teeth (Roberts and Manchester 1995:13).

If a tooth has been affected by severe wear, the chances are much higher of bacteria gaining access to the pulp cavity, leading to caries. This is evident in the dentition of the individual from burial feature 7. This individual, a female aged greater than 60 years, was found to have a large carious lesion involving the anterior ⅓ of the right maxillary third molar and the posterior ¼ of the right maxillary second molar. This, most likely, was the result of a high degree of attrition on the occlusal surfaces of the teeth. These teeth no longer had the benefit of a hard layer of enamel, and the pulp cavity became exposed (Fig. 6-2). Carious lesions were found also in the dentitions from individuals associated with burial features 11, 12, 17, 23, 24 and 28 (Table 6-1).

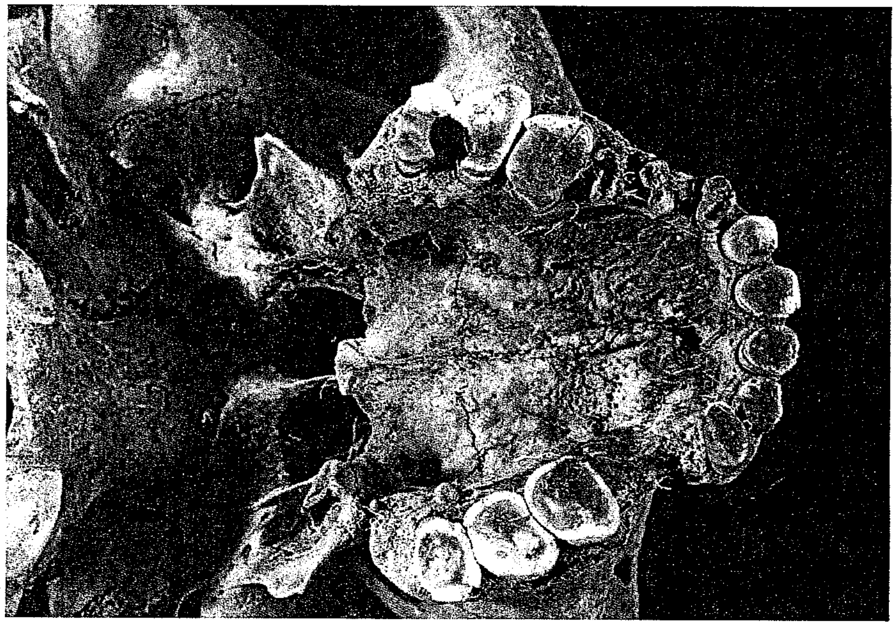

Figure 6-2: Evidence of caries in the dentition from the individual in burial feature 7.

TABLE 6-1

Carious lesions

Feature number	Location of lesion
7	-crowns destroyed by lesions – RP^2, RP^1, RC
	-large lesion involving the anterior ⅓ of RM^3 and posterior ¼ of RM^2
11	-small lesion on RM^1
12	-small lesions on RP^1 and RM_3
17	-medium lesions on LM^2 and LM_2
23	-medium lesion on LP_1
24	-large lesions on RM_2 and RP_1
28	-incipient caries on RM^3 and LM^1

6.3 Calculus

Calculus is the result of the mineralization of plaque, which is the combination of the micro-organisms found in the mouth along with proteins in the saliva (Roberts and Manchester 1995:55). It is often found on the teeth that are closest to the salivary glands. Many of the individuals from the St. Vital cemetery population had calculus deposits on numerous teeth (Table 6-2).

TABLE 6-2
Calculus deposit locations

Feature number	Location
7	-lingual side of mandibular incisors and canines
10	-both lingual and buccal/labial surfaces of the maxillary and mandibular dentitions
11	-lingual side of the mandibular incisors
12	-right buccal side of both maxillary and mandibular molars
15	-lingual surface of the mandibular canines, and the buccal surface of the right maxillary second molar
17	-buccal and labial surfaces of both maxillary and mandibular dentitions
18	-lingual surfaces of the mandibular premolars
23	-lingual surface of the right mandibular premolars
28	-labial surface of the mandibular left canine, first premolar and second premolar

6.4 Attrition

Dental attrition, which impacts both enamel and dentine, is the grinding action of teeth on each other resulting in worn occlusal surfaces (Roberts and Manchester 1995:52). It is not considered to be a pathological condition, but high amounts of attrition may indicate the location of incipient caries. Cultural activities, such as the brushing of teeth, results in abrasion. Tooth surfaces can also be worn down through erosion due to the presence of highly acidic foods. The mandibular dentition associated with burial feature 7 is a good example of the amount of attrition that can be present (Fig. 6-3).

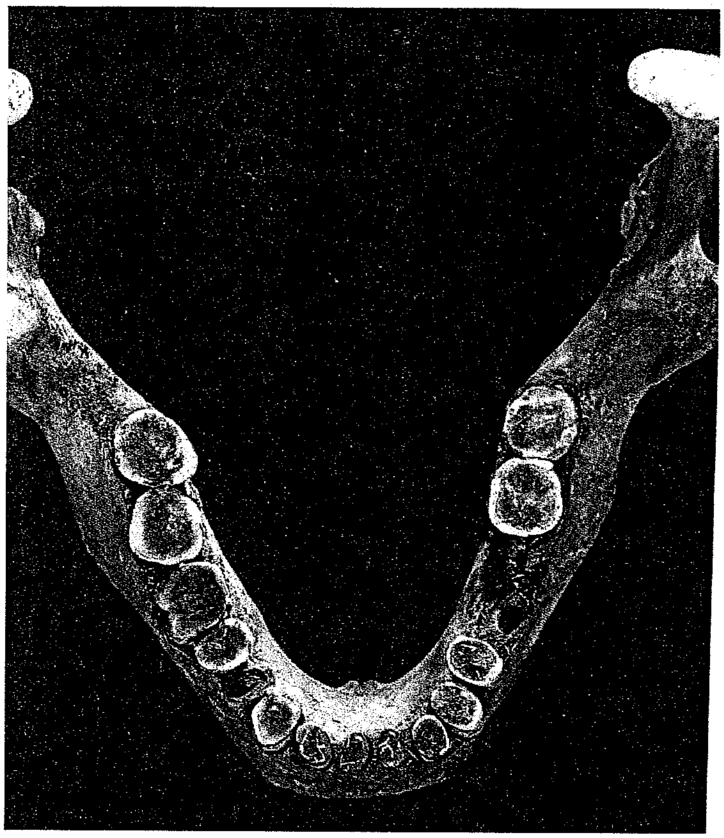

Figure 6-3: Attrition on the mandibular dentition from the individual in burial feature 7.

Because of the nature of attrition, it can be used as a marker in age assessment (Lovejoy 1985). While it needs to be used in association with other aging techniques because of cultural differences, the amount of attrition observed on an individual's dentition is a useful indicator of age. A well-known example of attrition research was conducted using skeletal remains from the Libben site, a Late Woodland population of Northern Ohio (Lovejoy 1985). Attrition was assessed on 332 adult dentitions with the recognition that the population had a regular pattern of wear based on a hunter-gatherer diet.

Precontact diets contained more grit-contaminated foods that resulted in rapid tooth wear. This makes it possible to correlate the amount of wear with the age of the individual (Walker et al. 1991). Modern attrition rates are slow because of our softer diet, although the amount of abrasion is relatively high as a result of using a toothbrush. Diet and cultural practices influence the rate of attrition, and although attrition assessment can be an indicator of age, the variability between populations results in the need for other aging techniques to be used in combination with attrition rates.

The degree of dental attrition associated with each adult recovered from the St. Vital Cemetery was assessed using the Arizona State University Dental Anthropology System (Turner et al. 1991). These results are tabulated in Table 6-3. The abbreviations used were according to the ASU Dental Anthropology System:

0	No wear.
0-1	Wear facets can be seen with a 10x-hand lens on one or more cusp occlusal planes
1	Dentin is exposed on one or more cusps.
2	Cusps worn off
3	Exposed pulp.
4	Root stump is functional. All or most of the enamel is worn off

A	Antemortem loss
C	Congenital absence
I	Impacted
P	Postmortem loss
U	Unerupted
-	Missing data

TABLE 6-3 Attrition Status

Burial	M3R	M2R	M1R	P2R	P1R	CR	I2R	I1R	I1L	I2L	CL	P1L	P2L	M1L	M2L	M3L
7 (F 60+)																
Upper	3	3	3	4	4	4	3	3	3	3	3	A	A	3	3	3
Lower	3.5	3.5	3.5	3	4	3	3	3	3	3	3	3	3	A	A	3
10 (F 20-25)																
Upper	1	1	1.5	1.5	1.5	1.5	1.5	2	2	1.5	1.5	1.5	1.5	1.5	1	1
Lower	1	1	1.5	1.5	1.5	1.5	1.5	2	2	1.5	1.5	1.5	1.5	1.5	1	1
11 (M 20-24)																
Upper	C	1	2	2	2	2	2	2.5	2.5	2	2	2	2	2	1	C
Lower	I	2	2	2	2	2	3	3	3	3	2	2	2	2	2	I
12 (M 25-30)																
Upper	1	1	2	2	2	2	3	3	3	3	3	2	2	2	1	1
Lower	1	1	1.5	A	2	2	3	3	3	3	2	2	2	2	1.5	1
14 (M 17-19)																
Upper	0	1	1	1	1	1	1.5	2	2	1.5	1	1	1	1	1	0
Lower	U	1.5	1.5	1	1	1	1.5	1.5	1.5	1.5	1	1	1	1.5	1.5	0
15 (M 18-20)																
Upper	1	1.5	2	1.5	1.5	1.5	2	2	2	2	2	1.5	1.5	2	1.5	1
Lower	.5	1	2	1.5	1.5	2	2	2	2	2	2	1.5	1	1.5	1	.5
17 (M 30-40)																
Upper	1	1.5	2	2	2	2	2	3	3	3	2	2	1.5	1.5	1.5	1
Lower	1	1.5	2	2	2	2	3	3	3	3	3	2	2	2	1.5	1
18 (F 30-35)																
Upper	C	1	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1	C
Lower	C	1	2	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1	C
23 (F 20-25)																
Upper	1	1.5	1.5	1.5	1.5	1.5	2	2	2	2	1.5	1.5	1.5	1.5	1.5	1
Lower	1	1	1.5	1.5	1.5	2	2	2	2	2	2	1.5	1.5	1.5	1.5	1
24 (M 30-34)																
Upper	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lower	C	4	P	A	4	P	2	P	2	2	1	1	P	P	A	-
28 (F 25-30)																
Upper	1.5	2	3	2	2	3	3	3	2	1*	2	2	2	3	2	2
Lower	1	2	3	3	3	3	3	3	3	3	3	3	2	3	2	1

6.5 Enamel Hypoplasia

Enamel hypoplasia, visible defects in the tooth enamel, was noticed in a few of the individuals from the St. Vital cemetery population, including burial features 24, 28 and SS1 (surface scatter 1 – see Appendix B). The defects on the dentition from the individual in burial feature 24 were located on the mandibular right second incisor, the left first incisor, the left second incisor and the left canine. According to the DDE Index (Developmental Defects of Dental Enamel), created by the Fédération Dentaire Internationale (FDI), a number code is used to identify the type of defect, the number, and demarcation of defects and the location of the defect (Hillson 1996:172). The number and type of defects identified in the individual in burial feature 24 were multiple (code 2-number), horizontal hypoplasia grooves (code 4-type), located on both the gingival and incisal halves (code 3-location) (Fig. 6-4).

Figure 6-4: Enamel hypoplasia on the mandibular dentition from the individual in burial feature 24.

Hypoplasial grooves were also evident on the dentition from the individual in burial feature 28. They were located on the surface of the mandibular right canine and the left first incisor. The defects belong to the same categories as those for the defects on the dentition from the individual in burial feature 24. A mandible associated with surface scatter 1 was discovered with enamel defects on the mandibular incisors.

Hypoplasia is the result of a disruption during the secretory phase of amelogenesis, or enamel formation (Suckling 1989). It is associated with childhood dietary stress, perhaps due to weaning. Hypoplasia is also associated with illness, but it is not usually possible to associate the defects with the original cause (Saunders and Keenlyside 1999). Enamel is acellular, and because of the lack of blood supply, disease impacts enamel differently than bone (Ortner 2003:589).

Enamel hypoplasia occurs during the developmental phase of crown formation and has been found on all teeth, including on teeth that have not yet erupted, except for the third molars (Lanphear 1990). The defects, which include lines, pits, or grooves on the enamel surface, are more commonly seen on the mandibular canines and the central maxillary incisors. If the stressful event took place within the first 25% of tooth formation, the defect will not be seen on the crown surface (Saunders and Keenlyside 1999). A permanent record of all enamel defects is retained into adulthood.

Examples of enamel hypoplasia include a study of a 19th century sample of individuals associated with the Anglican Church of St. Thomas in Belleville, Ontario (Saunders and Keenlyside 1999). The individuals were analyzed prior to reinterment with a research focus on the six maxillary and mandibular anterior teeth. They found only a small number of enamel defects with the peak of occurrence between the ages of two and four (Saunders and Keenlyside 1999). The researchers noted that these ages do not correspond with the likelihood that the defects were a result of weaning practices. Since they were studying an historical sample, access to documentary information on health and diet was available, but as enamel hypoplasia tends to be a non-specific indicator of stress, it was difficult to determine the actual cause of the defects.

Another historical sample used for the study of enamel defects were the dentitions from the skeletal remains associated with the cemetery of the Monroe County Poorhouse in New York, which was used between 1826 and 1863 (Lanphear 1990). The research was focused on the permanent maxillary central incisors and the mandibular canines. Distances were measured from the cementoenamel junction to the centre of each depression and then converted to an age of stress (Lanphear 1990). The peak ages were found to be 2.5 to 3 years for the maxillary central incisors and 3.5 to 4 years for the mandibular canines with no significant difference between males and females. These results show that while the Monroe County Poorhouse was designed for individuals who were in need, the goal of assisting the individuals was incompletely met because of poor construction of the establishment, lack of food, and non-existent health care (Lanphear 1990).

6.6 Supernumerary Teeth

Supernumerary teeth are often found in skeletal remains from an archaeological setting (Ortner 2003:598). This situation was discovered in the individual in burial feature 28, who was a female 25-30 years of age at death, from the St. Vital cemetery population. The individual was found with three supernumerary incisors. Two fully formed supernumerary teeth were located anterior to the left maxillary central incisor, while another supernumerary tooth was situated horizontally, superior to the right maxillary central incisor with the apex of the root anterior and the crown located within the maxilla. The individual was lacking a normal left maxillary second incisor (Fig. 6-5 and 6-6).

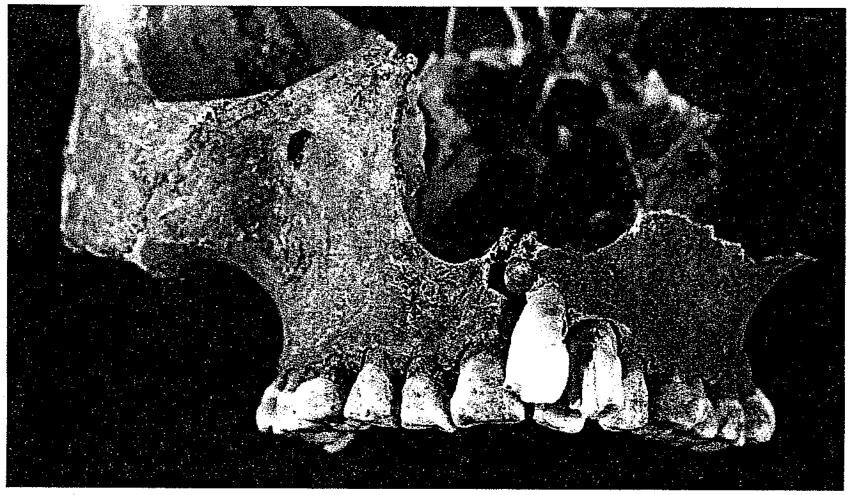

Figure 6-5: Supernumerary incisors in the maxillary dentition from the individual in burial feature 28.

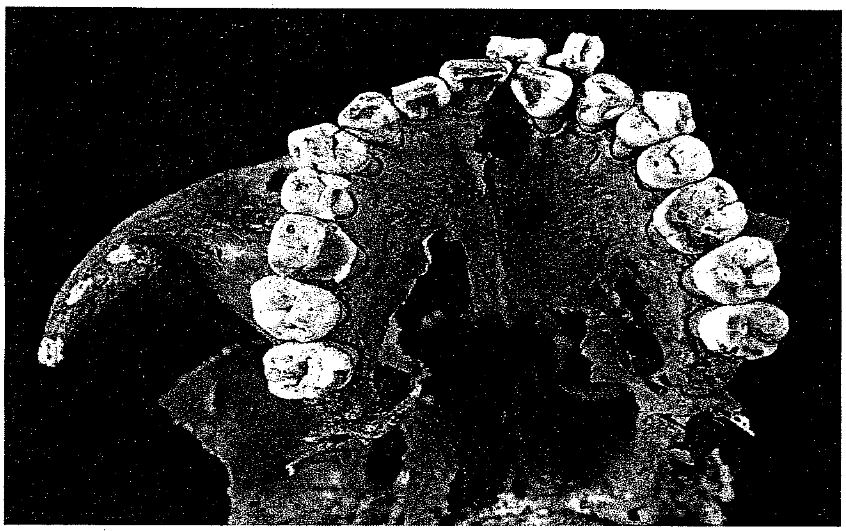

Figure 6-6: Occlusal view of the supernumerary incisors from the individual in burial feature 28.

Multiple supernumerary teeth are rarely found unless associated with a syndrome (Dowling and Delap 1997; Melamed et al. 1994). Some of these genetic syndromes include cleidocranial dysostosis, which leads to a defective ossification of the cranial bones, and Gardner's syndrome, which results in the development of systemic cancers. In fact, the anterior maxillary region is an unusual site for supernumerary teeth not associated with a syndrome (Dowling and Delap 1997; Yusof 1990). Multiple supernumerary teeth are more commonly seen in the mandible in the premolar area (Melamed et al. 1994).

Numerous theories abound as to the reason for the appearance of supernumerary teeth. These include atavism, heredity and genetically-determined conditions, dental lamina overgrowth and dichotomy of the tooth germ (Mason et al. 2000). Supernumerary maxillary incisors have been found to be more common in Asian populations with a male to female ratio of 2:1 (Mason et al. 2000). Modern dental care involves the extraction of supernumerary teeth to avoid impacting the neighbouring teeth by delaying eruption of permanent incisors or formation of cysts (von Arx 1992).

CHAPTER SEVEN: Congenital Conditions

7.1 Aural Atresia

A unique pathological condition was discovered associated with one of the individuals recovered from the St. Vital Cemetery. While the cranium belonging to the individual in burial feature 12 appeared relatively normal, the right external auditory meatus was non-existent. This condition is known as aural atresia, and it is rarely seen in an archaeological setting.

Aural atresia, a congenital deformity, is the result of the malformation of the external auditory canal (Fig.7-1). The middle ear, auricle and tympanic membrane may also be affected. Often the inner ear is normal and intact. It is important to recognize that the inner, middle and outer ear all develop independently, and malformation of one area is not an indication of malformation of other areas (De la Cruz et al. 1985). The impact to the auditory canal can range from mild to severe. While a mild case will still have part of the canal present, the external auditory canal is completely absent in a severe case, resulting in a loss of conductive hearing (De la Cruz et al., 1985).

The external auditory canal is formed during the 8th to the 28th fetal week and is derived from the first branchial cleft (Hodges et al. 1990). The middle ear, or tympanic cavity, transmits sound waves through the malleus, the incus and the stapes, also known as the three auditory ossicles. These ossicles, which articulate via synovial joints, are located between the tympanic membrane laterally and the oval window medially.

Ligaments and mucous membrane folds attach the ossicles to surrounding structures (Scheuer and Black 2000:70). The cartilaginous ossicles acquire their adult morphology and size between the 9th and 15th fetal weeks. They attain their final shape by the end of the fourth month when ossification begins (Crabtree 1982).

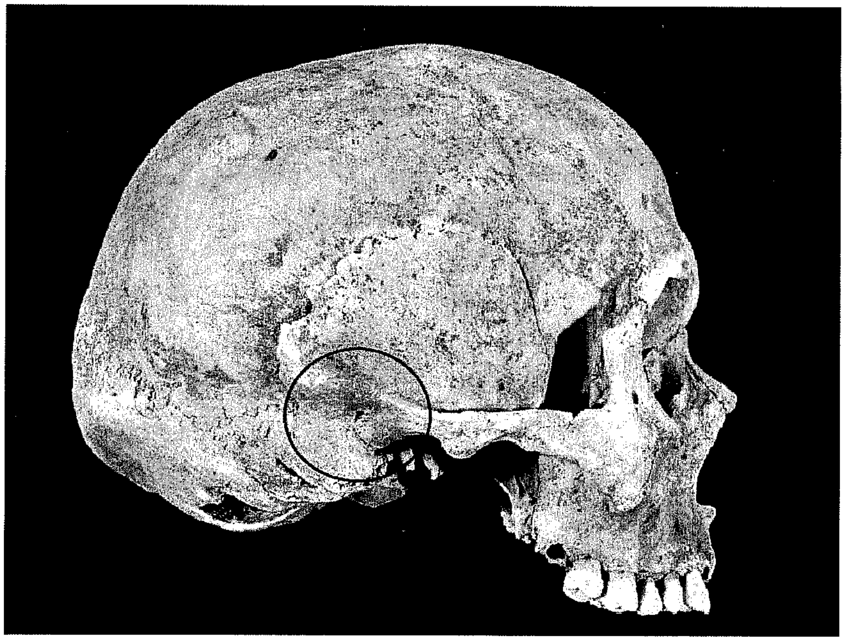

Figure 7-1: Lateral view of the cranium from burial feature 12 showing aural atresia

In severe aural atresia cases, the malleus and incus are under-developed or fused to surrounding bone. The stapes may also appear abnormal (Crabtree 1982). Dissection of the tympanic area in the cranium found in burial feature 12 revealed that the right malleus was misshapen and fused to the bone (Fig.7-2). The incus was not fused, but it had an abnormal appearance. The stapes was not located.

Without the external auditory canal, the temporomandibular joint is displaced posteriorly, and the anterior wall of the mastoid is in direct contact with the glenoid fossa (De la Cruz et al. 1985). This displacement was seen on the cranium found in burial feature 12, but there was relatively little asymmetry on the rest of the cranium other than the area involved with the aural atresia.

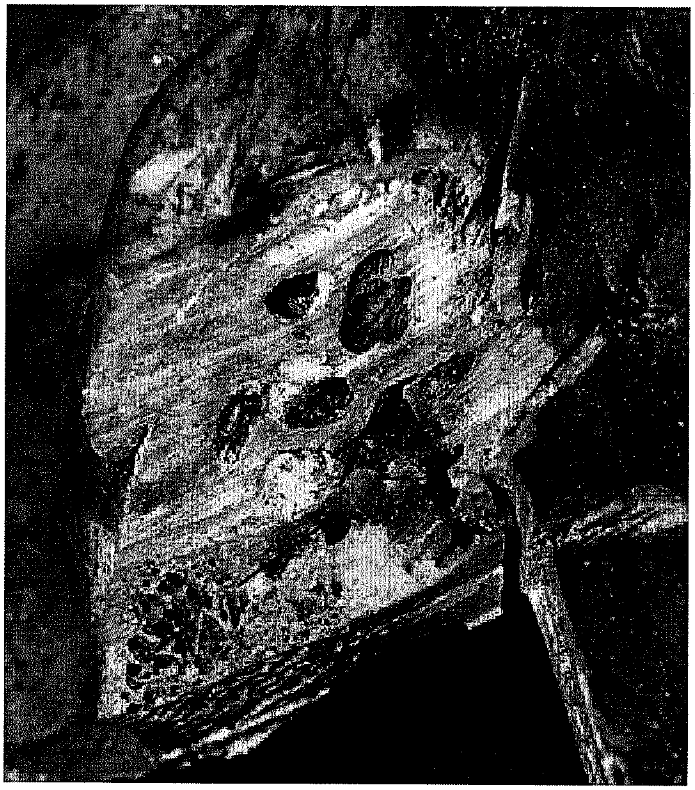

Figure 7-2: Abnormal middle ear with a fused malleus visible.

7.1.1 Prevalence

The rate of aural atresia in the average population is 1 in 10,000 to 1 in 20,000. In one study, 14% of individuals were found with a family history of atresia (Spring and Gianoli 1997). Unilateral cases of aural atresia are found approximately five to six times more than bilateral cases in the average modern population. Males are afflicted more commonly than females, and the defect is seen more often on the right side (Crabtree 1982).

Higher rates of congenital ear malformations occur in some Native American populations (Adams and Niswander 1968). Jaffe (1969) reports the incidence of aural atresia in Navajo children at 9.67 per 10,000. The auricles were found to be malformed, the tympanic membranes were absent and the middle ear ossicles were abnormal and fused.

7.1.2 Assessment and Surgery

The assessment of the extent of aural atresia is normally by the imaging method of computed tomography (CT), and audiometry, which measures the hearing of different frequencies. A good indicator of the severity of the pathological condition is the amount of mastoid air cell development, since it is the last area to develop (Spring and Gianoli 1997). A CT scan can also assess any inner ear abnormalities as well as the development of the ossicles and the middle ear.

In modern cases of aural atresia, surgery is an option for individuals wishing to acquire an increased sense of hearing. In fact, surgery for correcting aural atresia started in the early nineteen hundreds, but with a high failure rate and many complications (Spring and Gianoli 1997). The complex anatomy, such as the variability in the location of the facial nerve, results in challenging surgery (Andrews et al. 1992; De la Cruz et al. 1985).

If an individual has aural atresia bilaterally, hearing aids are used for the first few years, with reconstructive surgery occurring around the age of four or five when the patient is more co-operative and able to understand the procedure. Unilateral cases are either left alone if the child is able to hear enough with one ear, or the surgery is performed. If the hearing is sufficient in the normal ear, speech development is not impacted, but even if the normal ear looks fine, it may not function properly. Normal hearing is rarely obtained after surgery, therefore, the different factors need to be weighed before deciding on surgery with unilateral cases (Spring and Gianoli 1997).

Congenital aural atresia sometimes has an association with certain syndromes and diseases. For example, Crouzon's disease is a genetic disorder that may involve atresia, but abnormal cranial sutures, a widening of the skull, and hypoplasia of the maxilla also characterize the disease. The individual recovered from the St. Vital Cemetery displayed none of these other traits associated with Crouzon's.

Goldenhar's syndrome, normally detected in infancy, is a non-hereditary syndrome. Ocular problems and anomalies of the ear are seen in individuals with Goldenhar's, while post-cranial abnormalities include defects of the cervical spine. Again, these other traits were not seen in the skeletal remains from burial feature 12.

7.1.3 Archaeological Findings

A small number of papers have been published on ear abnormalities found on crania recovered from archaeological sites. Skeletal elements associated with the ear are often overlooked or not evident (Arensburg et al. 1977). Auditory ossicles are found to be relatively unimportant and care to retrieve them is sometimes not taken, as was the case initially when dealing with the St. Vital cemetery population. The individual's left ossicles were not found, and it was not possible to compare the malformed incus and malleus with those from the normal ear.

Aural atresia in archaeological populations is rarely found. Hodges et al. (1990) discuss a case of simple atresia with no middle or inner ear malformation from an individual found at a precontact Late Woodland site in Iowa. The individual was female, aged 30 to 40, and the pathological condition was found on her left side. After CT-scanning the cranium, they did not observe evidence of any other malformations. The stenosis was a thin bony plate and not an osteoma as is sometimes the case.

Wells (1962) presents a case of atresia found in Norfolk from the early Saxon period. The individual was a female aged 32 ± 4 years, and the defect was an occlusion of the right auditory canal. There was no trace of infection, and an osteoma was ruled out.

Hrdlicka (1933) reviews seven precontact cases from Peru (5), Arkansas (1), and New Mexico (1), all of which had aural atresia. The crania were all from individuals who had reached adult status except for one individual aged between 12 and 13 years at the time of death. Five of the adults were female, and one was male. The atresia was found only on the right side of each individual.

Arensburg (1977) reports on a 1600-year-old skull found in Israel that did not have aural atresia but was found with the right malleus fixed to the roof of the tympanic cavity. An infection of the middle ear may have caused this to occur, as inflamed areas are known to sometimes undergo osteoblastic activity.

7.1.4 Discussion

It is unusual to find an individual with the congenital condition aural atresia in an archaeological setting. Although it is not rare in modern times, aural atresia has not been seen with any regularity when human remains have been discovered. The individual from the St. Vital cemetery was found with severe aural atresia, and the assumption can be made that his hearing was restricted to his left side, if he could hear at all, as surgery to correct the malformation was not possible in the late nineteenth century. It is also likely that the right auricle was misshapen. This would have been visible to others, and may have had an impact on how the individual was treated. Simple wooden boxes were used to bury the individuals in the cemetery except for the individual with aural atresia, who had been placed directly in the ground. It is impossible to determine if the condition had any association with the different burial treatment.

CHAPTER EIGHT: Traumatic and Developmental Lesions

Trauma is the second most common pathological condition found on bone after degenerative skeletal changes (Ortner and Putschar 1981:55). This discussion will include a description of the healed fracture of the right fifth metacarpal associated with the individual from burial feature 24. Cranial deformation, particularly in the occipital region, was seen in the individual from burial feature 7 and will also be discussed in this chapter. Spondylolysis, or the failure of a vertebral arch to fuse to the body, was identified in burial features 14 and 23. This condition will be reviewed in this chapter because of the association of spondylolysis with stress fractures.

There are four ways that trauma can affect skeletal tissue. One of the most commonly recognized signs of trauma is a fracture or a bone break. Secondly, joints may become dislocated or abnormally displaced. Trauma may also result in the disruption of the blood or nerve supply. Lastly, an abnormal contour of bone that has been artificially or intentionally induced can also be categorized under trauma (Ortner 2003:119).

The study of trauma in a population aids in the definition of factors such as lifestyle, interpersonal violence and occupation. The success or lack of success of healing also relates to a population's access to sources of nutritional food and appropriate treatment (Roberts and Manchester 1995:65). It is important to recognize that many smaller injuries involving the soft tissue are no longer visible to a researcher. There are also limitations with trauma studies using archaeological populations, because it is difficult to determine the age of the individual at the time of the traumatic occurrence (Roberts and Manchester 1995:72).

8.1 Fractures

A fracture is a partial or complete break in a bone due to a traumatic event (Roberts and Manchester 1995:65). It can also be defined as a discontinuity of skeletal tissue with possible soft tissue involvement (Aufderheide and Rodriguez-Martin 1998:20). Fractures have been seen on skeletal remains from the time of *Homo erectus* through to the modern era (Ortner 2003:136).

Fractures are usually caused by an acute injury due to an accident or intentional violence, weakened bones from disease and improper nutrition, or repetitive stress that results in tears in the bone tissue (Roberts and Manchester 1995:68). In many archaeological samples with oblique breaks, it has been speculated that fractures are the result of accidental trauma rather than violence, as clinically more transverse fractures have been noted to be the result of intentional violence (Ortner 2003:136).

There are many types of force that result in a stress-induced fractured bone. These include tension, compression, torsion, flexion, and shearing (Ortner 2003:120). Stress on a bone can be dynamic, resulting in an immediate action, or the stress can be relatively low although over time a break still occurs. After a fracture has formed a callus and is in the process of healing, it is difficult to determine the type of stress that resulted in the fracture (Ortner and Putschar 1981:55). Without any evidence of healing, it is difficult to determine if a fracture occurred just prior to death or at the time of death.

It has been suggested that it takes at least two weeks after the fracture occurrence before the bone has visible signs of healing (Galloway et al. 1999).

Fractures are referred to as either open or closed. With an open fracture, the skin surface is involved and opened because of the bone break. This situation is more serious because the open skin allows bacteria to enter, resulting in an infection. A closed fracture is a broken bone that does not involve the skin surface.

The direction of a fracture may indicate how it occurred. A blow from a right angle that results in a horizontal break may create a transverse fracture. If the transverse fracture occurs in a younger individual, it will often be incomplete and this is referred to as a greenstick fracture. An indirect force can result in a spiral or oblique fracture. A fracture is comminuted when the bone is splintered into many fragments.

8.1.1 Healing of fractures

Fracture healing involves a number of steps including the formation of a callus and woven immature new bone. When the fracture occurs, blood vessels are broken, and a hematoma is formed. A fibrous callus is created that unifies the tissues. The final steps include calcification and remodelling, which results in the return of normal bone (Aufderheide and Rodriguez-Martin 1998:21).

A number of factors influence the rate of fracture healing, including the fracture type. For example, a spiral fracture will heal faster than a horizontal fracture. Also, the specific bone involved impacts the rate of healing, as for example, the tibia will often be the slowest bone to heal. The area of the bone will also influence the rate of healing. Cancellous bone has a faster rate of healing than cortical bone (Aufderheide and

Rodriguez-Martin 1998:21). An individual's age and nutritional status will have a large impact on the healing rate. Adult cortical bone will heal in about three months, while cancellous bone will heal in six weeks. The rate of fracture healing in children is twice as fast as the healing in adults (Ortner 2003:128). If a fracture is not realigned by properly setting the bone, it may end up shorter resulting in joint degeneration and osteoarthritis. Other complications include infection and tissue necrosis (Roberts and Manchester 1995:72)

A fracture study was completed by Lovejoy and Heiple (1981) of individuals associated with the Libben site in Ohio. They came to the conclusion that most of the fractures that were found had been the result of accidents. The fracture rate per individual was high, but the fractures were mainly seen in the 10 to 25 years of age group and the above 45 years of age group. The pattern of the ulna fractures was limited to only two 'parry' fractures, which is a fracture seen in individuals using their arms in defence during an attack.

8.1.2 Radiography

Fracture analysis is aided by radiographic techniques that allows for accurate angulation measurements and the revelation of the healing status (Roberts and Manchester 1995:72). Radiography is especially helpful when dealing with archaeological samples, because it can fill in some information gaps. It is relatively straightforward to radiograph a dry specimen, although different settings are needed due to the lack of soft tissue.

8.1.3 Metacarpal Fractures

Fractures in the hands and feet are not often seen in an archaeological setting. It is thought that this is partially due to the nature of these bones as they are smaller and do not preserve as well (Roberts and Manchester 1995:76). Studies have been shown that 35 percent of all hand fractures and 12 to 18 percent of upper extremity fractures occur in the fourth or fifth metacarpals (Braakman et al. 1996). The fifth metacarpal, which belonged to the individual in burial feature 24, had evidence of a well-remodelled upper midshaft fracture that resulted in a shortened bone (Fig. 8-1). Conservative treatment is the normal method for dealing with fourth and fifth metacarpal fractures (Theeuwen et al. 1991). Less than one percent of individuals in a study completed by Braakman et al. (1996) required internal fixation due to fracture instability. Manipulation is normally not necessary for treatment, but a cast will often be used to stabilize the fracture (Porter et al. 1988).

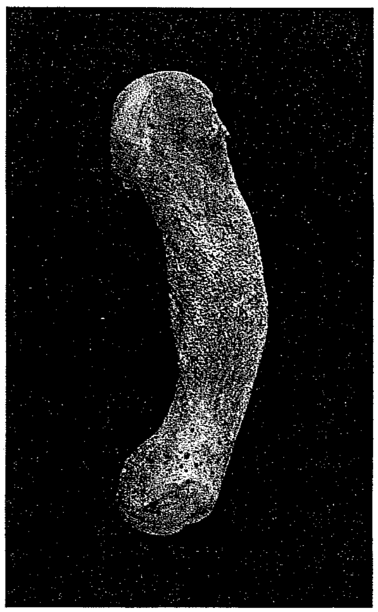

Figure 8-1: The right fifth metacarpal from the individual in burial feature 24.

8.1.4 Fractures related to occupation

Occupational activities may result in the nonfusion of epiphyses, imitating the appearance of a fracture. For example, an analysis was completed on scapulae recovered from individuals associated with the Tudor warship, the Mary Rose (Roberts and Manchester 1995:76). Separation of the acromial tip was found in 13.6 per cent of the individuals. It was suggested that non-union was the result of the movements necessary for archery practised at an early age. One example of an os acromiale, or a separated acromial tip, was found in one individual found in burial feature 11 from the St. Vital cemetery population. It is interesting to speculate whether this condition was the result of activities associated with the fur trade, such as rowing a boat.

8.2 Spondylolysis

Spondylolysis involves the separation or nonfusion of a vertebral arch from a vertebral body and has been found in skeletal material through antiquity. A discussion of the condition will be included here, although it is sometimes regarded as a congenital condition rather than the result of traumatic condition. The skeletal remains from burial features 14 and 23 were identified with spondylolysis of the fifth lumbar and fourth lumbar vertebrae respectively (Fig. 8-2 and 8-3). Stress fractures from constant activity result in a weakened area. A study of gymnasts showed that spondylolysis was found in 11.0 per cent of the female gymnasts (Jackson et al. 1976).

Differences in the numbers of individuals with spondylolysis have been recognized in various populations. This condition can be found in approximately three per cent of modern Caucasian populations, while a much higher percentage has been recorded in the Inuit population (Merbs 1995). The higher levels of spondylolysis were thought to be the result of the small size and isolation of the population. A situation such as this suggests that the condition is under genetic control (Ortner 2003:147).

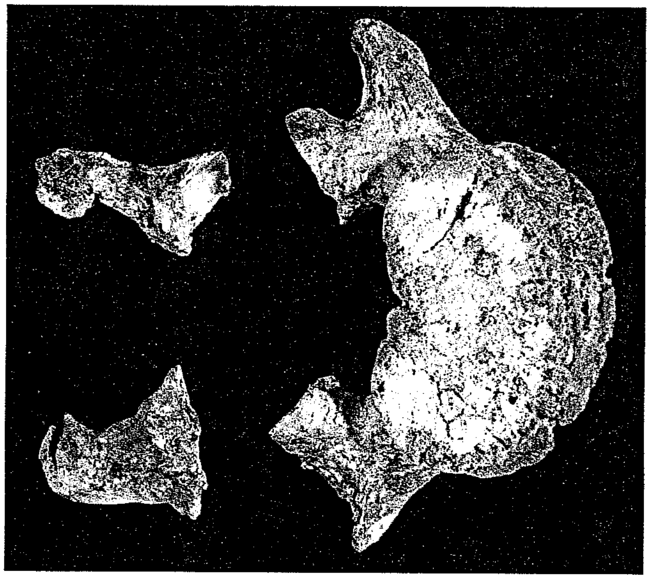

Figure 8-2: Spondylolysis of the fifth lumbar vertebra from burial feature 14.

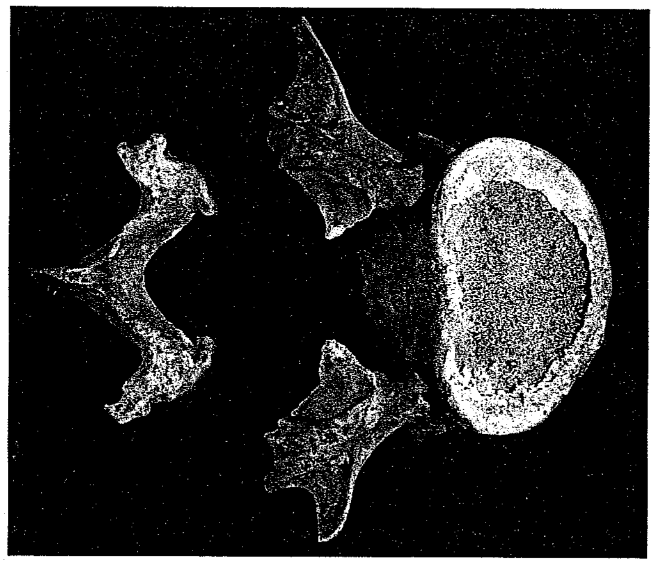

Fig. 8-3: Spondylolysis of the fourth lumbar vertebra from burial feature 23.

It is believed that there are multiple reasons for the appearance of spondylolysis, but most commonly it appears to be the result of low-grade stress in the lower back resulting in a fatigue fracture (Ortner 2003:148). This condition is usually symptom-free unless the vertebral body becomes dislocated, which leads to spondylolisthesis.

8.3 Cranial Deformation

A bone can be modified over time through intentional or accidental methods. The deformity may become permanent, especially if it occurs during a period of growth. It has been suggested that even with slight pressure, some types of deformation will occur if the pressure lasts over a long period of time (Ortner 2003:163).

Cranial deformation was visible in the individual from burial feature 7, who was a female aged greater than 60 years of age at the time of death (Fig. 8-4). This individual had an extremely flattened occipital, which leads to the possible conclusion that as an infant she may have been placed on a cradleboard. The amount of occipital flattening can be measured by constructing an index that relates the inion-obelion arc to the inion-obelion chord. Cranial flattening can be seen at 93% and is definite at 95% (Olivier 1969:145). The index for the cranium from burial feature 7 is 96.9%.

It is well known that some of the Native American groups, including the Plains Cree, used a cradleboard with their infants. In the historical period, it was possible to purchase the cradleboards from the Hudson's Bay Company. The women who used the cradleboards were seen as possessing a luxury item (Mandelbaum 1979:140). The boards were rectangular with an arc of wood at the head. A holder for the child was made by incorporating a U-shaped wooden rim on the face of the board four inches from the margins (Fig. 8-5).

Figure 8-4: Cranial deformation (occipital flattening) on the individual from burial feature 7.

There were a few consequences that resulted from cradleboard use. The pressure and friction of the infant's head on the board may have allowed for the production of ischemic ulcers and created conditions favourable for bacterial infections (Holliday 1993). Cranial deformation does not affect the brain tissue, as the final volume of tissue remains the same, and the brain does not become compressed or impaired (Aufderheide and Rodriguez-Martin 1998:35)

Figure 8-5: Cradleboard use during the 19th century (Harrison 1985:11).

CHAPTER NINE: Metabolic Disease and the Presence of Lead

9.1 The impact of lead

In modern society, lead is found virtually everywhere. Soils that do not involve lead ore outcroppings have an average lead level of 16 ppm (Aufderheide 1989). Diagenesis involves the post-mortem changes in the bone chemistry (Sanford and Weaver 2000). If the soil pH is neutral or alkaline, lead is poorly soluble thereby reducing the potential for a diagenetic effect on the bone, while acidic soils have more potential for a diagenetic effect (Aufderheide 1991). Cortical bone is often chosen for analysis because it is less susceptible to diagenesis. Also, cortical samples will have less variation in the lead concentration within one individual. Cortical bone has a slower turnover rate than cancellous bone and can represent more of an individual's lifetime (Sanford and Weaver 2000).

Lead can be acquired into the body through inhalation as well as absorption. Children have ingested lead through paint chips, food, and soil (Wittmers et al. 2002). Ingested lead in children is far more serious than lead ingested in adults, as almost 50% of the lead may be absorbed through the intestines in children, while only 10% of the ingested lead is absorbed in adults (Aufderheide 1989). Lead that enters the system is either excreted or stored within the skeletal framework. It has been estimated that 90% of the lead that has been ingested from food is excreted (Farrer 1993), but for the remaining lead, almost 95% will be found in the skeletal framework (Lovell 2000).

Lead can be stored for decades in the hydroxyapatite crystal of bone mineral (Wittmers et al. 2002), which is part of the inorganic phase that composes 77% of bone (Sanford and Weaver 2000). This level will vary between the various bones in an individual, which is why it is important to choose consistent bone samples for testing.

Studies involving rats have shown that exposure to lead during pregnancy and lactation resulted in hyperactive offspring with less exploratory behaviour. The weaned rats had learning and memory deficiencies, while the adults were more anxious. The levels of lead were in ranges that may be comparable to lead levels found in children who are chronically exposed to lead (Moreira et al. 2001).

Muscle weakness, partial nerve paralysis, and abdominal colic are symptoms of lead poisoning (Lalich and Aufderheide 1991). Additional symptoms also include fatigue, irritability, paranoia, and anaemia. This is why the theory still remains that the crew from the 1848 Franklin expedition, who were searching for the Northwest Passage, suffered from lead poisoning. The unusual artifact finds recovered from an expedition life-boat including items such as silk handkerchiefs, slippers, and haircombs, may signify the altered state of the minds of the crew members (Beattie and Geiger 1998:39).

9.2 St. Vital skeletal lead analysis and results

In the late nineteenth century, arsenic was used as an embalming agent, and due to the presence of potential soft tissue in some of the individuals, bone samples were analyzed for their concentration of arsenic. At the same time, the analysis included a determination of the concentrations of many chemical elements in addition to arsenic.

The analysis was performed at the University of Saskatchewan Department of Geological Sciences in the ICP-MS (Inductively Coupled Plasma Mass Spectrometer) laboratory. Initially, tissue samples were only chosen from two of the individuals from the cemetery population. These samples included a distal phalanx and a fingernail from the individual found in burial feature 7 and a temporal bone fragment and possible abdominal tissue from the individual associated with burial feature 11. The results indicated that there was no arsenic in the samples, but high concentrations of lead were detected. As well, the level of lead in the environment was determined to be negligible through the analysis of a control soil sample from the burial area.

Upon receipt of the results, it was determined that lead tests were necessary on bone samples from the rest of the individuals. Financial constraints resulted in using samples from only burial features 2, 8, 10, 12, 18 and 24 for lead analysis. The individual that was found in burial feature 2 was the youngest, at 32 fetal weeks, to be tested. The left scapula was chosen from this feature for the analysis, while a capitate, or carpal bone, was selected from each adult and juvenile chosen for the lead assessment. The results were interesting although some inconsistencies are present (Table 9-1). Similar to the initial results, the newly analyzed samples also indicated high lead levels, including the sample from burial feature 2, which included the 32-fetal-week infant.

TABLE 9-1 Lead Concentrations

Burial feature number	Estimated age (years)	Concentration of lead (ppm)
Background		8.42 (sand from site)
2	32 fetal weeks	60
7	60+ F	190 (0.48 ppm - fingernail)
8	10-12	142
10	20-25 F	89
11	20-24 M	200 (6.6 ppm - possible soft tissue)
12	25-30 M	203
18	30-35 F	32
24	30-34 M	75

9.3 Lead Use

Lead has been used for millennia. Areas in the Middle East contain evidence of lead technology from six thousand years ago. The use of lead increased during the Greek Classical Age, and it is speculated that the mining and processing of lead ore had an impact on the health of those involved (Aufderheide 1991). The Industrial Revolution brought about a resurgence in lead technology, which resulted in an increased exposure to lead.

Colonial Americans were exposed to lead daily through items such as eating utensils composed of pewter dishes and flatware. Many containers were also lead-lined (Lalich and Aufderheide 1991). Perishable beverages were stored in lead-lined containers because the beverages would preserve longer due to the impact of lead ions on spoilage bacteria.

Settlers in Canada were also exposed to lead through cooking utensils such as lead-lined copper pots, which were used to improve the taste of liquids that would otherwise take on a copper metallic taste (Aufderheide 1991). Additional lead sources included the glazes used to finish ceramics. Lead was also found in hardware, buttons, medicinal ingredients, and cosmetics. Also, lead acetate was used to counteract acidity in ciders and wines (Farrer 1993).

At Rocky Mountain House, a 19^{th} century fur trading post in Alberta, items such as copper kettles, lead glazed ceramics, tobacco, and tea packaged in lead-lined foil were also being used (Carlson 1996).

> When the Hudson's Bay Company shipped tea to the outposts it came in large packages that were greatly prized by Indians fortunate enough to have muzzle loaders. The packages contained lead which the

> Indians saved, melted, and poured out in long strips on a smooth flat rock. When it had cooled, a sharp knife was used to cut it into small pieces and calling all his children together, the father would have them chew the pieces into fine balls (Carpenter 1977:39).

Historically, the exposure to lead through a variety of sources was quite likely.

9.4 Lead concentrations associated with other cemeteries

A lead analysis was completed on samples of bone from individuals buried in a pioneer cemetery (Aufderheide 1991). The Harvie family cemetery, which was found in southern Ontario, was used between 1825 and 1894. Two grams of cortical bone from the femora were used for the lead analyses. The mean bone lead content of the individuals, whose average age at death was 54.3 years, was 52.7 ppm. This value is twice what is found in modern populations, but considering the widespread use of lead in that time, it was not surprising to find higher levels (Aufderheide 1991).

Two anomalies were found in the lead results. One 98-year-old female had a bone lead level of 178.1 ppm, and a 48-year-old male was found to have a 93.9 ppm level of lead. While it is not unusual for an older individual to have a high level of lead, as lead accumulates in bone over time, these lead levels were extremely high when extrapolating from the results of the other individuals. Also, the lead concentration identified in the 48-year-old male was unusually high, and this suggests occupational exposure in addition to the everyday lead exposure received by the community (Aufderheide 1991).

Skeletal lead analyses have also been performed on bone samples from individuals dating to the time of plantations during the seventeenth and eighteenth centuries in the southern United States. Slaves worked on the plantations, but it was found that they had a different lead exposure than the plantation owners and families. The expensive leaded glass and pewter plates were used in the higher status homes, while the dishes and cutlery used by the slaves were often unglazed earthenware. A skeletal lead content of 185 ppm was found in a wealthy owner's family member, while the mean lead content of the slave group interred in a segregated cemetery was only 35 ppm (Aufderheide 1989). Through the use of historical documents and skeletal lead testing, predictions regarding the status of individuals are possible.

Another study of skeletal lead content involved the analysis of bone samples from slaves who worked at a colonial Barbados sugar plantation. The slave population was found to have a very high lead concentration with a mean of 120 ppm and a range up to 424 ppm (Wittmers et al. 2002). A correlation was found between the amount of bone lead and the age of the individuals. The youngest individual had the least amount while the older individuals had the greater amounts. This is in contrast to the small amount of skeletal lead found in the slaves who worked on the continental plantations. Sugar was produced at the Caribbean plantations, and the methods that were used involved a large amount of lead.

The skeletal lead content was tested from 27 soldiers who fought in the War of 1812 and are now buried in the Snake Hill Military Cemetery in Ontario. The average lead level was 31.3 micrograms per gram of bone ash (Lalich and Aufderheide 1991). Two values were found to be outside the range of the expected lead amount. At 82.9 and 113.1 micrograms, and a soldier mean age of only 25.5 years, these results indicate the possibility that these two individuals may have belonged to wealthier families. It was not unusual in that time for a son from a wealthy family to be accepted into the army (Lalich and Aufderheide 1991).

It is noteworthy to draw attention to the Franklin expedition, as it relates to the discussion of lead poisoning. This expedition, which left London on May 19, 1845, was attempting to discover the Northwest Passage when something unexplained happened because the whole crew perished before reaching their final destination. This mystery has taken decades to solve, and there still is not a complete consensus among researchers about the events that may have taken place.

One of the theories regarding the demise of the crew involves lead poisoning due to the lead solder used to seal the cans of food (Beattie and Geiger 1998:160). Eight thousand tins of processed meat, soup and vegetables, along with 17,749 litres of liquor and 4200 kg of lemon juice were packed on to the ship. The solder used to seal the cans of food was composed of ninety percent lead and ten percent tin. In Victorian England, lead sinks and lead pipes were additional sources of lead contamination. On board the two Franklin expedition ships, the *Erebus* and the *Terror*, lead sources included the pewter table service, lead-foil-wrapped tobacco, pottery glaze, as well as 'brass' uniform buttons that were painted with lead (Anonymous 1989).

A sample of occipital bone from a Franklin crewmember that was found on King William Island in 1981 was tested. The lead level was 228 ppm, while bone samples from three nearby Inuit skeletons had levels that only ranged from 22 to 36 ppm (Beattie and Geiger 1998:83). These lower lead levels are expected if someone only had an exposure to environmental lead.

Excavations continued a few years later when Dr. Owen Beattie and his team excavated three known burials of men who were crewmembers on the Franklin expedition. Hair samples were analyzed to determine if lead exposure occurred just prior to the demise of the individuals. While one sailor, John Hartnell, had a high hair lead level of between 138 and 313 ppm, the other sailor, John Torrington, had levels even higher from 413 to 657 ppm. William Braine, the third crewmember, had levels between 145 and 280 ppm (Beattie and Geiger 1998:160).

In the Franklin case, the researchers attempted to determine the source of lead in the sailors' bones through lead isotope studies. They found that the isotope ratios were very similar between the Franklin tins and the Franklin bone samples (Kowal et al. 1991). This suggested that the lead poisoning came directly from the lead found in the tin cans taken with them on the journey. This conclusion has been challenged, as it was known that lead was a component in a number of sources in both North America and England in the nineteenth century. Water was tested from a house in Scotland that still had Victorian plumbing, and the lead isotope ratio was found to be very similar to the Franklin samples (Farrer 1993).

A second argument relates to the use of hair as a way of determining the amount of lead exposure. The Franklin hair samples indicated high lead levels, but this has been criticized due to problems with the techniques used and varying lead levels found between single hairs (Farrer 1993). Thirdly, due to the nature of lead as solder in tin cans, the possibility of the lead moving into the food, especially a low acidic food, is very slim. The lead is electrolytically inhibited both by the tin in the plate as well as the tin in the solder (Farrer 1993).

Further investigations were completed after bones from an unrecorded Franklin expedition campsite were recovered from King William Island in 1993 (Keenleyside 1996). Lead analyses were performed using a technique involving the fluorescence excitation of lead x-rays. If an individual has only environmental lead exposure, the various bones in that individual will have similar lead levels. The highest levels were recorded in trabecular bone, which has a rapid turnover rate. The Franklin samples had different lead levels in the bones from the same individual. It was theorized that these individuals had a shorter duration of additional lead exposure due to the higher levels of lead found in the calcanei as compared to the tibiae (Keenleyside 1996).

9.5 Discussion of the St. Vital cemetery skeletal lead results

Due to financial constraints, only a small number of samples were tested for their lead concentrations. The bone selections were not seen to be crucial as the initial tests were for arsenic. As the tests continued, it was decided that to remain consistent, the same bone should be chosen from the different individuals, namely the right capitate, a carpal from the wrist.

The results indicated high amounts of lead in each individual tested, but the data are lacking in comparisons to cortical bone samples, which is now the norm for lead testing (Aufderheide 1989). Although, as the turnover in trabecular bone is higher than in cortical bone, speculations can be made regarding the significance of the result. Considering the use of lead in the 19th century, the St. Vital cemetery population was likely exposed to lead prior to death. The results are not consistent though with respect to showing increased lead levels associated with the older individuals.

CHAPTER TEN: Circulatory Disorders and Degenerative Joint Disease

10.1 Osteochondritis dissecans

Osteochondritis dissecans is characterized by the necrosis of a segment of bone involved in the articulation process (Loveland et al. 1984). It has also been described as the separation of a fragment of articular cartilage with or without subchondral bone (Madhok 1987). The lesion can appear crater-like with rugged walls. Osteochondritis dissecans is more common in individuals, especially in males, between the ages of 15 and 25 (Zimmerman and Kelley 1982) and has rarely been diagnosed in individuals over the age of 40 years (Aufderheide and Rodriguez-Martin 1998:82).

The femoral condyle is the most common location of osteochondritis dissecans (Aufderheide and Rodriguez-Martin 1998:82; Lehman and Gregg 1986). It has also been observed in the foot with involvement of either the navicular, first metatarsal, or the base of the first hallucial phalanx (Loveland et al. 1984). Occasionally, more than one joint may be affected in an individual, and commonly, if multiple joint involvement is present, it will include the corresponding bone on the opposite side.

The cause of osteochondritis dissecans is considered to be the result of an impaired blood supply. It is possible that some individuals are predisposed to the condition, while others may have osteochondritis dissecans as the result of trauma (Zimmerman and Kelley 1982). Approximately 50% of patients have a history of a trauma that impacted the area involved with osteochondritis dissecans (Lehman and Gregg 1986).

The condition has been found in young athletes, which suggests that constant low-grade trauma plays a role in the development of minor bone necrosis (Aufderheide and Rodriguez-Martin 1998:81).

If pain is an issue for the patient, one solution is to surgically excise the lesion with drilling and abrasion. The joint is then protected until fibrocartilage forms, and the area is healed (Lehman and Gregg 1986). When osteochondritis dissecans is visualized radiographically, the bone peripheral to the crater-like depression will appear sclerotic (Zimmerman and Kelley 1982). The condition often goes unrecognized if the sclerotic area or evidence of necrosis can not be seen radiographically.

This condition has rarely been discussed in the paleopathological literature. Skeletal elements can be impacted by soil erosion or other disease processes such as osteoarthritis, which leads to an increased difficulty in diagnosing ancient specimens with osteochondritis dissecans (Loveland et al. 1984).

10.1.1 Historical background

The condition was first described by Sir James Paget in 1870 (Anderson 2001) and referred to as osteochondritis dissecans in 1888 when F. Konig coined the term in reference to a loose body in a knee (Lehman and Gregg 1986). Archaeological specimens have been identified, but certain joints are rarely found with evidence of osteochondritis dissecans. For example, the skeletal remains of a medieval individual, aged 13 to 15 years, were observed to have signs of osteochondritis dissecans. The unhealed lesion was located in an atypical site involving the distal articular surface of the right medial cuneiform, which is an area not reported in either clinical or archaeological papers (Anderson 2001).

10.1.2 Evidence of osteochondritis dissecans in the St. Vital cemetery population

This condition was also found in an unusual site on one of the individuals from burial feature 23. Osteochondritis dissecans was discovered bilaterally in the feet involving both the lateral cuneiforms and the third metatarsals (Fig.10-1). The individual from burial feature 23 was estimated to be female, with an age at death of between 20 and 25 years. In addition to displaying evidence of osteochondritis dissecans, the individual also had spondylolysis of the fourth lumbar vertebra. Current cases of osteochondritis dissecans that involve the feet are associated with pain and the inability to move about (Anderson 2001). The St. Vital individual had this condition bilaterally, and although familial osteochondritis dissecans is rare (Paes 1989), a genetic predisposition to the condition is a more likely scenario than trauma.

Figure 10-1: Osteochondritis dissecans on the distal surface of the lateral cuneiforms and the proximal surface of the third metatarsals from the individual in burial feature 23.

Osteochondritis of the lateral cuneiform has also been identified in a modern case of a two-year-old child (Mubarak 1992). The child had a painful limp that lasted for a number of months. The diagnosis of osteochondritis was made after viewing x-rays of the area, which showed sclerotic changes on the articular surface of the lateral cuneiform. The lesion eventually resolved, and the child was able to walk pain-free. Prior to the discovery of osteochondritis dissecans on the lateral cuneiforms belonging to the individual in burial feature 23, the modern case involving the two-year-old is apparently the only other recorded case of lateral cuneiform involvement.

10.2 Degenerative Joint Disease

Degenerative joint disease is the most common pathological condition involving arthrodial joints. It has been identified in various archaeological skeletal remains, including in the remains of Neandertals and skeletal remains from the Bronze Age (MacLennan 1999). Joint disease has also been observed in the skeletal remains of three males associated with the Fur Trade Period in Alberta. It was suggested that the skeletal changes may have been due to habitual lifting and rowing (Roberts and Manchester 1995:110).

Degenerative joint disease is a noninflammatory, progressive disease that is sometimes seen by the fourth decade of life, and the degeneration continues as the individual ages (Aufderheide and Rodriguez-Martin 1998:93). By the age of 60 years, the condition has been identified in more than 50% of people in the Western countries (Ortner 2003:545).

Degenerative joint disease is characterized by the loss of cartilage that results in bone on bone contact. Osteological evidence includes both bone erosion and proliferation (Roberts and Manchester 1995:101). The non-erosive condition is referred to as osteoarthritis (Rothschild 2002). Approximately 80% of the diagnosed degenerative joint cases are idiopathic, while 20% of cases are the result of a traumatic event or disease (Aufderheide and Rodriguez-Martin 1998:93).

The progression of the disease involves the initial loss of cartilage followed by bone remodelling and new bone formation (osteophytes). Advanced cases may have evidence of eburnation or formation of reactive bone on the subchondral compact bone as a result of the bone on bone contact within the joint (Ortner 2003:546). The large weight-bearing joints are usually affected first, such as the knee, which is the most common area to find degenerative joint disease (Aufderheide and Rodriguez-Martin 1998:94).

Evidence of degenerative joint disease was discovered on vertebrae from two of the individuals in the St. Vital cemetery population. When vertebrae are involved, the condition is often referred to as osteophytosis. Degeneration of a vertebral disk results in the situation where the two vertebrae are in closer contact with each other, and new bone growth is stimulated resulting in osteophytes around the margins. The lower cervical, lower thoracic, and lumbar areas are affected first as these areas are involved with more spinal movement (Dawson and Trinkaus 1997). Minor evidence of osteophytes was seen on the lumbar vertebrae of the individual from burial feature 17. On the other hand, the individual in burial feature 7, who was an older (60+ years) female, had significantly more evidence of osteophytosis (Fig. 10-2). This is not surprising because of the individual's advanced age.

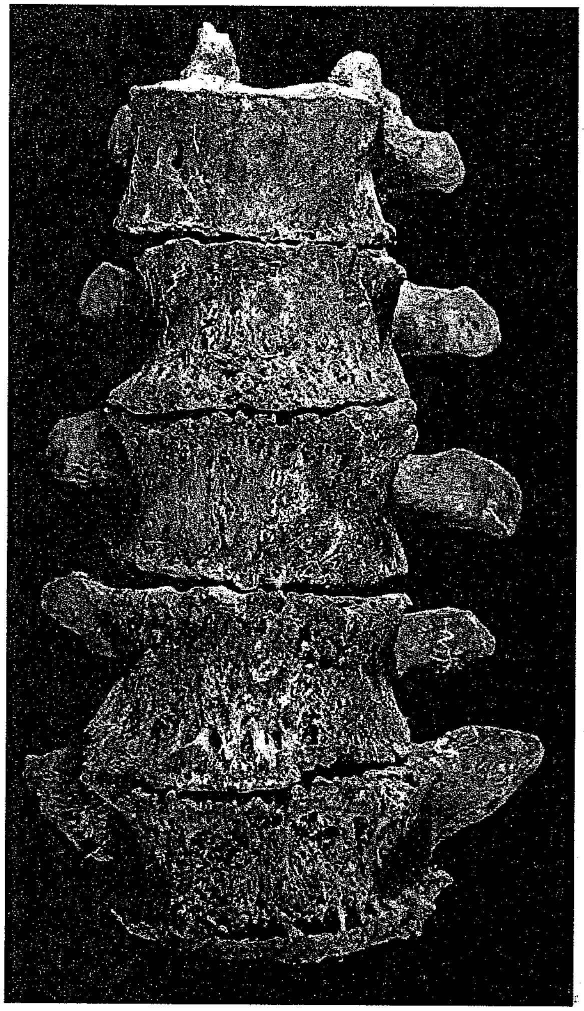

Figure 10-2: Osteophytes on the lumbar vertebrae from the individual in burial feature 7.

Osteophytes can also be located on the distal interphalangeal joints. Women are more commonly diagnosed with degenerative joint disease in this area (Ortner 2003:549). Bone lipping and osteophyte growth were observed in the phalanges associated with the individual in burial feature 7. Degenerative joint disease was also located in the right elbow region of this same individual (Fig. 10-3).

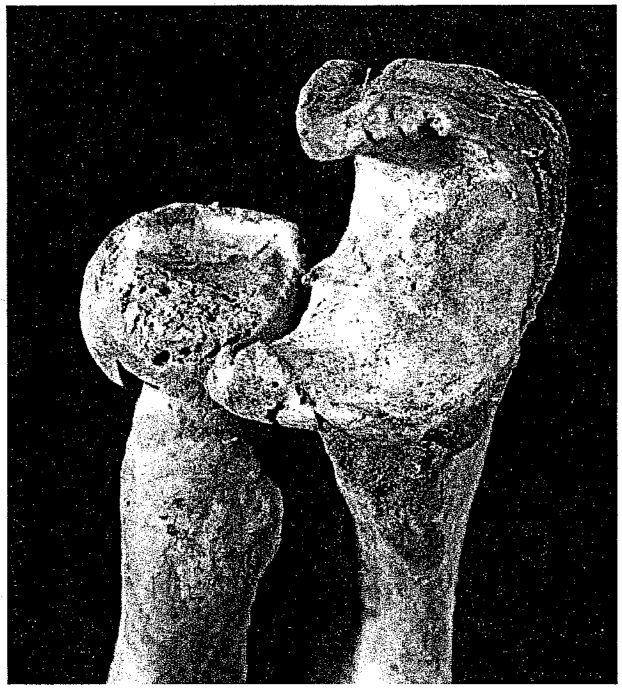

Figure 10-3: Evidence of degenerative joint disease in the right elbow joint of the individual associated with burial feature 7.

CHAPTER ELEVEN: The Presence of Disease

11.1 Infectious Disease

Osteological evidence of infectious disease is relatively uncommon in modern times as a result of antibiotics that are used to treat bacterial diseases. Infections are usually resolved before they have a chance to impact the skeletal system. When evidence of a bone infection is discovered in an archaeological setting, it likely was caused by a bacterial infection and not by a virus, because viral infections were either quickly fatal or the individual's immune system was strong, and the infection was controlled (Roberts and Manchester 1995:125).

In the later years of nineteenth century Saskatchewan, many infectious diseases were prevalent. Reserve living, crowded conditions, and limited access to food supplies due to the loss of the buffalo, led to the starvation of many First Nations individuals and resulted in the circulation of diseases such as measles, scarlet fever, whooping cough and pulmonary tuberculosis (Lux 2001:41). Numerous French Métis began the journey to the Northwest Territories after the 1870 Red River insurrection. When the buffalo were still a resource, they continued to hunt, but declining buffalo numbers also impacted the Métis. However, it has been documented that some of the Métis were still better off than the First Nations individuals who were confined to reserves (Harrison 1985:46).

During the late 1870s and early 1880s, many diseases that were previously endemic became epidemic in proportion. Poor nutrition impacted immune systems, and the lack of proper housing and supplies resulted in overexposure of many individuals to the elements. The winter weather of 1883-1884 was especially severe across the prairies (Lux 2001:51). Viral and bacterial diseases such as smallpox, tuberculosis, and diphtheria also impacted the Métis population post-1885 (Harrison 1985:64).

Specific diseases such as tuberculosis, the treponemal diseases, and leprosy leave characteristic infective lesions on bone. Other types of bacteria involved in bone infections are staphylococci, streptococci, and pneumococci, and they often find their way to the bone tissue through the circulatory system. The original infected area may have been the chest or throat, but in the pre-antibiotic era there was a higher chance of an infection spreading.

The repair process entails the development of new bone on the surface. Osteoblasts are bone forming cells that synthesize extracellular material including collagen that eventually results in the formation of new bone. This new bone initially lacks any organization and resembles a woven type of pattern. Osteoclasts, the bone absorptive cells, remodel the bone to resemble the form of mature compact bone (Roberts and Manchester 1995:126).

Many individuals, during the time frame of 1879 to 1885, were affected by tuberculosis. Consumption was a common diagnosis, as it was the term used by the doctors to indicate pulmonary tuberculosis. There are different types of tuberculosis depending on the type of transmission and the organism involved. *Mycobacterium tuberculosis* is the organism responsible for the human infection, although, bovine tuberculosis can also be spread to humans. Human to human transmission of the disease occurs through exposure to the sputum and excreta from individuals suffering from the infection.

During the time prior to antibiotics, the incidence of tuberculous skeletal involvement was detected in 5 to 7% of the infected individuals (Aufderheide and Rodriguez-Martin 1998:133). The skeletal evidence of tuberculosis, due to the circulation of the tubercle bacilli in the bloodstream, is often located in areas where hemopoietic marrow was located, such as the vertebrae, ribs and sternum (Ortner 2003:228). The diagnosis of skeletal tuberculosis is usually based on the spinal lesions. Other affected areas may include the hip and knee joints. This was sometimes followed by septic arthritis that resulted in the destruction and fibrous fixation of the joint (Roberts and Manchester 1995:137).

Another skeletal indication of tuberculosis may be diffuse periostitis, an osteological reaction involving the periosteum that stimulates bone growth. Three individuals from the St. Vital cemetery population were identified with periostitis. The individual associated with burial feature 7 was observed to have periostitis on the left proximal tibia, while the individual associated with burial feature 15 had periostitis on the second lumbar vertebra (Fig. 11-1). The third individual, who was associated with burial feature 28, was identified with periostitis on the inferior surface of an unidentified left rib (Fig. 11-2). Modern cases of tuberculosis have seen involvement of the ribs in 9% of the infected individuals (Ortner 2003:246). Periostitis was also discovered on the right lingual side of the individual's mandible (Fig 11-3).

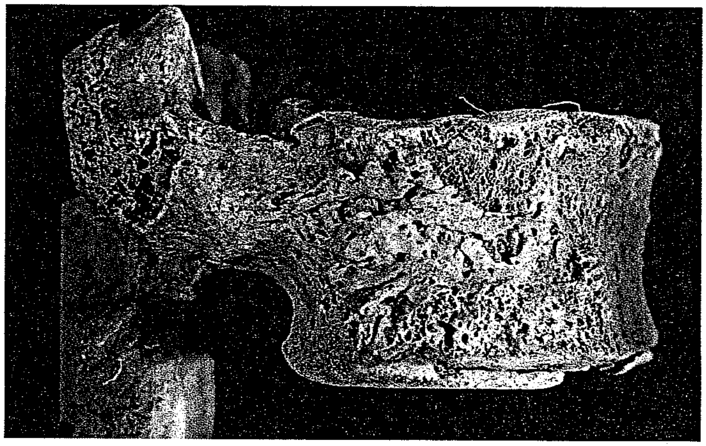

Figure 11-1: Periostitis on the second lumbar vertebra from the individual associated with burial feature 15.

Two pathological conditions, namely trauma and infection, result in periostitis (Ortner 2003:208). Bones that are closer to the surface are more likely to be affected by trauma. In the lesions identified in the St. Vital cemetery population, most of the impacted areas were located in deeper areas within the individual with the exception of the tibial periostitis observed on the individual associated with burial feature 7. The tibial diaphysis is one of the most common sites that periostitis has been identified in archaeological skeletal remains (Ortner 2003:209).

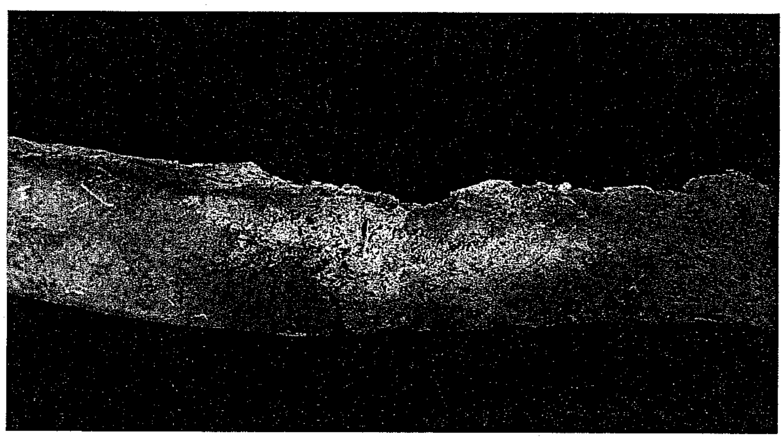

Figure 11-2: Evidence of periostitis on a left rib from the individual associated with burial feature 28.

Figure 11-3: Periostitis on the inner surface of the mandible from the individual associated with burial feature 28.

11.2 Harris Lines

The tibiae from a number of the younger individuals were radiographed with the anticipation of identifying Harris lines, which are transverse lines of radiodensity that are created during times of disease and poor nutrition (Aufderheide and Rodriguez-Martin 1998:423). These lines were visualized in the individuals associated with burial features 13 (approximate age at death of nine years), 19 (approximate age at death of 1.5 to 2 years), and 20 (approximate age at death of 2.5 years).

The greatest numbers of lines are usually seen in the tibiae. The lines are formed when the cartilage stops growing in the epiphyseal plate, but the bone growth continues in the diaphysis, which results in high-density bone that can be seen on a radiograph (Hughes et al. 1996). The lines can range in thickness from less than 1mm to greater than 1 cm (Larsen 1997:40).

When identifying Harris lines, inter-individual variation has been observed. Lines may be detected in some of the long bones, but not seen in others. When only one bone is examined, the results are not as accurate as when both can be analyzed due to the lack of symmetry (Hughes et al. 1996).

> It is unwise to rely on the results of a single bone or one type of long bone alone either to indicate the health status of an individual, or as the basis for assessing the health status of a small population (Hughes et al. 1996).

Harris lines may be formed prenatally (Grolleau-Raoux et al. 1997). They have also been seen in infants at one month of age, but the lines were not present at birth, which is indicative of possible birth trauma (Hughes et al. 1996). Harris lines in adults are not as common as they are affected by normal bone remodelling processes. If long bones from adults are radiographed and lines are discovered, more lines may have once been visible but are no longer present due to the loss of bone mineral (Aufderheide and Rodriguez-Martin 1998:423). Adult lines are inaccurate and result in limited information.

The standard method for determining the number of Harris lines, which are visible on the radiograph, is to count the lines that extend at least a quarter of the way across the diaphysis (Hughes et al. 1996). When lines are not visible, this should not be taken to indicate that the individual was healthy. If the infection or nutritional deficiency was severe and resulted in the individual's death, they would not have evidence of Harris lines because the lines are formed during the recovery process. It is difficult to associate the lines with other stress indicators such as enamel hypoplasia for reasons that are not yet clear (Aufderheide and Rodriguez-Martin 1998:423).

CHAPTER TWELVE: Conclusions

The recovery of 30 individuals from a rediscovered cemetery south of Battleford, Saskatchewan, resulted in the opportunity to learn about a late nineteenth century population through skeletal analyses. The bone preservation of the adult individuals, in particular, was very good with the exception of the individual associated with burial feature 14. Excellent preservation allowed for a detailed assessment of the skeletal remains. Documentary sources indicated that the cemetery was only used for a time span of six years between 1879 and 1885. With the known short time frame, it is possible to make some general conclusions about the past population as well as speculate on the health status of each individual based on the information that was obtained through the skeletal assessment.

Firstly, the cause of death was not apparent for any of the individuals. Historical documentation has provided evidence that many of the individuals in the Battleford area in the late nineteenth century were dealing with starvation and infectious disease (Lux 2001:33). While the skeletal evidence from the individuals of the St. Vital cemetery did not give any clear indication as to why the individuals died at relatively young ages, the lack of pathological skeletal evidence supports the documentary records that indicated the population's struggle with starvation and disease.

One of the effects of poor nutrition is the decreased ability of the immune system to deal with infectious microorganisms. This leads to serious consequences when a disease is spread from community to community. If the disease leads to the death of an individual within a short time frame, the evidence of the infection will not be seen osteologically, as was the case with the St. Vital cemetery population. It can be speculated that due to the young ages in the St. Vital cemetery, an epidemic situation may have occurred. It is likely that the older members of the community may have had immunity from previous infections, while the younger individuals were susceptible to any new infections. A likely candidate for the epidemic may have been smallpox, as this disease was a cause for great concern in that time period.

In the previous chapters, an overview of the population's dental health, evidence of congenital and traumatic conditions, as well as a discussion of disease was presented. Of particular interest was the discovery of relatively high skeletal lead concentrations. While the lead levels were much higher than modern standards, the levels were very comparable to results obtained by other researchers studying the bone lead concentrations of nineteenth century individuals. It is not surprising to discover that individuals who lived in the nineteenth century had evidence of lead exposure due to the fact that a number of items that contained lead, including foil and glazes, were used in that time period.

The St. Vital cemetery excavation was very reminiscent of a similar undertaking that occurred in Fort Qu'Appelle, Saskatchewan in 1985. In that community, a nineteenth century cemetery (EeMw-27) was rediscovered during construction activities (Walker 1986). It was thought that the cemetery was associated with the Church Missionary Society of the Qu'Appelle Lakes Mission, which was established in 1856. A total of 27 individuals were identified, but circumstances resulted in the detailed skeletal analysis of only a small number of the individuals (Walker 1986).

There were a number of similarities that were noticed between the information that was gathered at the St. Vital cemetery and at the Fort Qu'Appelle burial site. While the cemetery population sizes were small, the demographics were still somewhat similar as it appeared that a variety of age groups were represented in both sites, although the majority was relatively young. The lack of traumatic pathologies and the young ages of the individuals suggest that an epidemic had been present during both time periods. Epidemics are known to impact the whole population, with the exception of older individuals who may have survived the same disease at a younger age, resulting in immunity.

Another Canadian cemetery excavation in Belleville, Ontario resulted in the acquisition of an abundance of information. St. Thomas' Anglican Church was associated with a cemetery that had also been used in the nineteenth century. The modern day church population wanted to build a parish hall on the property over what had been the burial ground, but it was not known how many individuals had been interred in that area (Saunders et al. 1995).

The 1989 excavation was a large undertaking, and at that time, it was one of the largest excavated historic cemeteries in North America. An impressive amount of data was collected through radiography, photography, and tissue sampling. A total of 579 grave shafts were identified, and the preservation tended to depend on whether the individual was a child or adult. The skeletal remains of children and infants do not preserve as well as they are not fully mineralized, and this may have caused an under-representation of the number of children who were buried at the cemetery.

The Belleville Anglican Church cemetery excavations also showed how important it is to recognize that materials documenting major crises may not be completely accurate. It has been found that under-reporting is often the case during events such as epidemics and famines due to the difficulty of maintaining detailed statistics during stressful periods (Saunders et al 1995).

Biases need to be recognized before undertaking an historic cemetery excavation. This was learned from the excavation of the Cross cemetery in central Illinois, which was associated with a homestead. While initial observations seemed to indicate a low life expectancy for the Cross family members, the children who had survived into adulthood most likely moved away and were buried elsewhere (Larsen et al. 1995). It is misleading to only look at the cemetery by itself without recognizing that the demographics may not accurately represent that particular family.

The Christ Church, Spitalfields excavation in England was a massive undertaking between the years of 1984 and 1986. Over 900 human skeletons had been interred between 1729 and 1859, and these were recovered in an attempt to create space for the modern church. Fortunately, forty percent of the skeletons were found to be associated with coffin plates that included the name of the individual, the age at death and the date of the death. These details were crucial in assessing the accuracy of the osteological analysis and helped to remove some of the biases by adding to the information (Cox 1995).

Historical cemeteries, especially in North America, are representative of different cultural events including settlement, warfare, struggles with epidemics, religious conversion and frontier life. It is possible to make parallels from the skeletal population to events such as these as long as the link is made carefully. Documentary evidence can play an important role in determining how close the assumptions from the skeletal studies are to the actual reality.

The recovery and analysis of historical burials offers a unique opportunity for scientific study that includes the areas of osteology and paleopathology. The additional incorporation of historical data adds to the wealth of information.

> Historical collections are also very useful for testing the assumptions that bioarchaeologists make when they reconstruct the lifeways of prehistoric people...differences between demographic reconstructions based on skeletal remains and burial records can provide insights into the limitations of palaeodemographic studies and suggest strategies for circumventing them [Walker 1995:31].

The St. Vital cemetery relocation offered this unique opportunity for scientific study, especially from a paleopathological perspective, and the research was rounded out more fully with the insight from the documentary analysis.

By studying past diseases through a skeletal population, this information may be of use to the modern populations. For example, tuberculosis is still a concern in Saskatchewan today, but if the disease is identified in a skeletal population, it may allow researchers to determine how the disease is evolving. This will potentially lead to increased research and treatments for the modern populations impacted by the disease.

The study of past disease through the various methods is worthwhile even if the impact of the disease did not affect the mortality rate of the populations at that time.

Minor conditions due to simple trauma and dietary deficiencies would still have had cultural repercussions for they would have affected the individual's capacity to work, or the condition may have had an impact on the reproductive capabilities (Goodman 1993). Once the minor health indicators are placed into a larger picture, assumptions can be made about the health and success of the group.

The St. Vital cemetery relocation also led to the necessity to bring together a number of interest groups, each with their own perspectives. This included the involvement of the landowners, the Heritage Resource Branch of the Department of Culture, Youth and Recreation, the Rural Municipality of Battle River, the Battleford Tribal Council, the Roman Catholic Diocese of Prince Albert and the University of Saskatchewan. This project was an interesting case in how it is very important to keep everyone involved and informed when dealing with the sensitive nature of cemetery relocation.

A final component of the project involved the reinterment of the skeletal remains at the Battleford cemetery. On October 17, 2002, the skeletal remains were placed in separate plain boxes and transported to the cemetery where a short service was held, with prayers given by Fr. Chris Szezepanek of the St. Vital Parish in Battleford, and a drumming ceremony performed by members of the community.

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Abbreviations Used in the Appendices

P	Present
N	Not Present
M	Missing Data
FU	Fused
I	Incomplete
FI	Fragmented and Incomplete
U	Unerupted tooth
PU	Present but unidentifiable

Appendix A1 - Inventory, Metrics and Nonmetrics of Burial Units 7 to 15

Burial Feature Number	**7**	**8**	**10**	**11**	**12**	**14**	**15**
Cranium							
Complete	P	P	P	P	P		P
frontal						I	
occipital						I	
r. parietal						FI	
l. parietal						P	
r. temporal						FI	
l. temporal						P	
r. zygomatic						I	
l. zygomatic						FI	
r. maxilla						P	
l. maxilla						P	
r. sphenoid						I	
l. sphenoid						P	
mandible	P	P	P	P	P	P	P
sternum							
manubrium	P	P	P	P	P	FI	P
body	P	P	P	P	P	N	P
xiphoid							
left ribs	12	11	12	12	12	11	11
right ribs	11	11	12	12	12	11	12
carpals							
r. scaphoid	P	N	P	P	P	I	P
l. scaphoid	N	N	P	P	P	P	P
r. lunate	P	P	P	P	P	I	P
l. lunate	P	N	P	P	P	P	P
r. triangular	P	N	P	P	P	I	P
l. triangular	N	N	P	P	P	P	P
r. pisiform	N	N	P	P	P	N	N
l. pisiform	N	N	P	P	P	P	P
r. trapezium	P	N	P	P	P	P	P
l. trapezium	P	N	P	P	P	P	P
r. trapezoid	P	N	P	P	P	P	P
l. trapezoid	P	N	P	P	P	P	P
r. capitate	P	P	P	P	P	I	P
l. capitate	P	N	P	P	P	P	P
r. hamate	P	N	P	P	P	I	P
l. hamate	N	N	P	P	P	I	P
r. metacarpal 1	P	P	P	P	P	I	P
l. metacarpal 1	P	N	N	P	P	P	P
r. metacarpal 2	P	N	P	P	P	I	P
l. metacarpal 2	P	N	P	P	P	P	P
r. metacarpal 3	P	N	P	P	P	I	P
l. metacarpal 3	P	N	P	P	P	P	P
r. metacarpal 4	P	N	P	P	P	I	P
l. metacarpal 4	P	N	P	P	P	I	P
r. metacarpal 5	P	N	P	P	P	I	P

l. metacarpal 5	P	N	P	P	P	I	P
prox manus phalanges	10	2	9	9	9	5	9
mid manus phalanges	7	0	6	7	8	0	7
distal manus phalanges	8	0	7	9	7	1	8
r. scapula	P	FI	P	F	FI	FI	P
l. scapula	P	FI	I	P	FI	FI	I
r. clavicle	P	I	P	P	P	I	P
l. clavicle	P	I	P	P	P	I	P
r. humerus	P	I	P	P	P	I	P
l. humerus	P	I	P	P	P	P	P
r. radius	P	I	P	P	P	FI	P
l. radius	P	I	P	P	P	P	P
r. ulna	P	I	P	P	P	I	P
l. ulna	P	I	P	P	P	P	P
r. innominate	P	P	P	P	P	I	P
l. innominate	P	P	P	P	P	P	P
r. femur	P	P	P	P	P	FI	P
l. femur	P	I	P	P	P	FI	P
r. tibia	P	I	P	P	P	FI	P
l. tibia	P	I	P	P	P	FI	P
r. patella	P	N	P	P	P	FI	P
l. patella	P	P	P	P	P	FI	P
r. fibula	P	FI	F	P	P	FI	P
l. fibula	P	FI	I	P	P	FI	P
tarsals							
r. calcaneus	P	P	P	P	P	P	P
l. calcaneus	P	P	P	P	P	P	P
r. talus	P	P	P	P	P	P	P
l. talus	P	P	P	P	P	P	P
r. cuboid	P	P	P	P	P	P	P
l. cuboid	P	N	P	P	P	P	P
r. navicular	P	P	P	P	P	P	P
l. navicular	P	P	P	P	P	P	P
r. cuneiform 1	P	P	P	P	P	P	P
l. cuneiform 1	P	P	P	P	P	P	P
r. cuneiform 2	P	P	P	P	P	P	P
l. cuneiform 2	P	P	P	P	P	P	P
r. cuneiform 3	P	P	P	P	P	P	P
l. cuneiform 3	P	N	P	P	P	P	P
r. metatarsal 1	P	P	P	P	P	P	P
l. metatarsal 1	P	N	P	P	P	P	P
r. metatarsal 2	P	P	P	P	P	P	P
l. metatarsal 2	P	N	P	P	P	P	P
r. metatarsal 3	P	N	P	P	P	P	P
l. metatarsal 3	P	P	P	P	P	P	P
r. metatarsal 4	P	N	P	P	P	P	P
l. metatarsal 4	P	N	P	P	P	P	P
r. metatarsal 5	P	P	P	P	P	P	P
l. metatarsal 5	P	P	P	P	P	P	P
prox pes phalanges	7	1	10	9	5	10	9
mid pes phalanges	4	1	4	3	3	5	2
distal pes phalanges	6	1	6	7	4	2	3

sesamoids	3	0	1	3	2	2	1
TEETH							
maxillary dentition							
RM3	P	U	P	N	P	P	P
RM2	P	P	P	P	P	P	P
RM1	P	P	P	P	P	P	P
RP2	P	P	P	P	P	P	P
RP1	P	N	P	P	P	P	P
RC	P	P	P	P	P	P	P
RI2	P	P	P	P	P	P	P
RI1	P	P	P	P	P	P	P
LI1	P	N	P	P	P	P	P
LI2	P	P	P	P	P	P	P
LC	P	P	P	P	P	P	P
LP1	N	P	P	P	P	P	P
LP2	N	N	P	P	P	P	P
LM1	P	P	P	P	P	P	P
LM2	P	P	P	P	P	P	P
LM3	P	U	P	N	P	P	P
mandibular dentition							
RM3	P	U	P	P	P	P	P
RM2	P	P	P	P	P	P	P
RM1	P	P	P	P	P	P	P
RP2	P	P	P	P	N	P	P
RP1	P	P	P	P	P	P	P
RC	P	P	P	P	P	P	P
RI2	P	P	P	P	P	P	P
RI1	P	P	P	P	P	P	P
LI1	P	P	P	P	P	P	P
LI2	P	P	P	P	P	P	P
LC	P	P	P	P	P	P	P
LP1	P	P	P	P	P	P	P
LP2	N	P	P	P	P	P	P
LM1	N	P	P	P	P	P	P
LM2	P	P	P	P	P	P	P
LM3	P	U	P	P	P	P	P
VERTEBRAE							
C1	P	P	P	P	P	P	P
C2	P	P	P	P	P	P	P
C3	P	P	P	P	P	P	P
C4	P	P	P	P	P	P	P
C5	P	P	P	P	P	P	P
C6	P	P	P	P	P	P	P
C7	P	P	P	P	P	P	P
T1	P	8PU	P	P	P	P	P
T2	P		P	P	P	P	P
T3	P		P	P	P	P	P
T4	P		P	P	P	P	P
T5	P		P	P	P	P	P
T6	P		P	P	P	P	P
T7	P		P	P	P	P	P
T8	P		P	P	P	P	P

T9	P		P	P	P	P	P
T10	P		P	P	P	P	P
T11	P		P	P	P	P	P
T12	P		P	P	P	P	P
L1	P	P	P	P	P	P	P
L2	P	P	P	P	P	P	P
L3	P	P	P	P	P	P	P
L4	P	P	P	P	P	P	P
L5	P	P	P	P	P	P	P
sacrum	P	P	P	P	P	P	P
caudal	1	0	0	3	1	2	0
DISCRETE TRAITS							
Ossicle at lamda	N	N	N	N	N	M	P
Ossicle at asterion R	N	N	N	N	N	M	N
Ossicle at asterion L	P	N	N	N	N	M	N
Bregmatic bone	N	N	N	N	N	M	N
Inca bone	N	N	N	N	N	M	N
Parietal Notch Bone R	N	N	N	N	N	M	N
Parietal Notch Bone L	P	N	N	N	N	M	N
Pterionic Bone R	N	N	N	N	N	N	N
Pterionic Bone L	N	P	N	N	N	M	N
Lambdoid Ossicles R	N	N	P	P	P	M	N
Lambdoid Ossicles L	N	N	P	P	P	M	N
Sagittal Ossicles	N	N	N	P	N	M	N
Coronal Ossicles R	N	N	N	N	N	M	N
Coronal Ossicles L	N	N	N	N	N	M	N
Metopism	N	N	N	N	N	N	N
Mastoid Suture R	N	N	N	N	N	M	N
Mastoid Suture L	N	N	N	N	N	N	N
Bipartate Parietals R	N	N	N	N	N	M	N
Bipartate Parietals L	N	N	N	N	N	M	N
Os Japonicum R	N	N	N	N	N	N	N
Os Japonicum L	N	N	N	N	N	N	N
Fronto-temporal art R	N	N	N	N	N	M	N
Fronto-temporal art L	N	N	N	N	N	N	N
Suture into Infraorb F R	N	P	N	P	N	M	P
Suture into Infraorb F L	N	P	N	P	N	M	P
Obelionic F R	N	N	N	N	N	M	N
Obelionic F L	N	N	N	N	N	M	N
Secondary Frontal F R	N	P	P	P	N	N	P
Secondary Frontal F L	N	N	N	P	N	N	N
Acces Infra-orbital F R	P	P	N	P	P	N	N
Acces Infra-orbital F L	P	N	N	P	N	N	N
Access Mental F R	N	N	N	N	N	N	N
Access Mental F L	N	N	N	N	N	N	N
Acces Optic C R	N	N	N	N	N	N	N
Acces Optic C L	N	N	N	N	N	N	N
Ant Condylar C Bridge R	N	N	N	N	N	N	N
Ant Condylar C Bridge L	P	N	N	N	N	N	N
Post Condylar C Bridge R	N	N	N	N	N	N	N
Post Condylar C Bridge L	N	N	N	N	N	N	N
F of Huschke R	N	P	N	N	N	M	N

F of Huschke L	N	N	N	N	N	P	N
F Ovale Incomplete R	N	N	N	N	P	N	N
F Ovale Incomplete L	N	N	N	N	N	N	N
F Spinosum Open R	N	N	N	P	P	M	N
F Spinosum Open L	N	N	N	N	P	N	N
F of Versalius R	N	N	N	P	N	M	N
F of Versalius L	N	N	N	N	N	N	N
Supraorb Nerve Impress R	N	N	N	N	N	N	P
Supraorb Nerve Impress L	N	N	N	N	N	N	P
Bridge Mylohyoid Groove R	N	N	P	N	N	N	N
Bridge Mylohyoid Groove L	N	N	N	N	N	N	N
Pharyngeal Fossa	N	N	N	N	N	N	N
Condylar Facet Double R	N	N	N	N	N	N	P
Condylar Facet Double L	N	N	P	N	N	N	P
Precondylar Tubercle	N	N	N	N	N	N	N
Sagittal Keel	N	N	N	N	N	M	N
Occipital Bun	N	N	N	N	N	M	N
Palatine Torus	N	N	N	N	N	N	N
Maxillary Torus R	N	N	N	N	N	N	N
Maxillary Torus L	N	N	N	N	N	N	N
Auditory Exostosis R	N	N	N	N	N	N	N
Auditory Exostosis L	N	N	N	N	N	N	N
Absence Max 3rd molar R	N	N	N	P	N	N	N
Absence Max 3rd molar L	N	N	N	P	N	N	N
Absence Mand 3rd molar R	N	N	N	N	N	N	N
Absence Mand 3rd molar L	N	N	N	N	N	N	N
rotated max premolar 2 R	N	N	N	N	N	N	N
rotated max premolar 2 L	N	N	N	N	N	N	N
rotated mand premolar 2 R	N	N	N	N	N	N	N
rotated mand premolar 2 L	N	N	N	N	N	N	N
parietal foramen R	P	N	P	P	P	M	N
parietal foramen L	N	N	P	P	P	M	N
marginal foramen R	N	N	N	N	N	M	N
marginal foramen L	N	N	N	N	N	N	N
accessory hypoglossal canal R	N	N	N	N	N	N	N
accessory hypoglossal canal L	N	P	P	N	N	N	N
frontal grooves R	N	N	P	N	P	M	P
frontal grooves L	N	N	P	N	P	M	P
infraorbital suture R	N	N	N	P	N	M	P
infraorbital suture L	N	N	N	P	N	M	P
pterygoid bridge R	N	N	N	N	N	M	N
pterygoid bridge L	N	N	N	N	N	M	N
clinoid bridge R	N	N	N	N	N	N	N
clinoid bridge L	N	N	N	N	N	P	N
trochlear spur R	N	P	N	P	N	N	N
trochlear spur L	N	P	N	N	N	N	N
paracondylar process R	N	N	N	N	N	M	N
paracondylar process L	N	N	N	N	N	M	N
pharyngeal fossa R	N	N	N	N	N	N	N
sternum-sternal aperture	N	N	N	N	N	N	N
scapula-os acromiale R	N	N	N	P	N	N	N
scapula-os acromiale L	N	N	N	N	N	N	N

humerus-septal aperture R	N	N	N	N	N	N	N
humerus-septal aperture L	N	N	N	N	N	N	N
innominate-acetabular mark R	N	N	N	N	N	N	N
innominate-acetabular mark L	N	N	N	P	N	N	N
femur-third trochanter R	N	N	N	P	P	P	P
femur-third trochanter L	N	N	N	P	P	N	P
patella-vastus notch R	N	M	N	N	P	M	N
patella-vastus notch L	N	N	N	N	P	M	N
patella-bipartate R	N	M	N	N	N	N	N
patella-bipartate L	N	N	N	N	N	N	N
tibia-dist ant squat facet R	P	N	N	N	P	N	P
tibia-dist ant squat facet L	P	N	N	P	P	N	N
calcaneus-bipart ant talar facet R	N	P	N	N	N	N	P
calcaneus-bipart ant talar facet L	P	P	N	N	N	N	P
talus-os trigonum R	N	N	N	N	N	N	N
talus-os trigonum L	N	N	N	N	N	N	N
atlas-f transversarium incomp R	N	P	N	N	N	N	N
atlas-f transversarium incomp L	N	M	N	N	N	N	N
atlas-spina bifida	N	N	P	N	N	N	N
atlas-bifid anterior arch	N	P	N	N	N	N	N
axis-f transversarium incomp R	N	M	N	N	N	N	N
axis-f transversarium incomp L	N	N	N	N	N	N	N
cervicle-f. transversarium bridge F	N	M	P	N	N	M	P
cervicle-f. transversarium bridge I	N	M	N	N	N	M	P
cervicle-spina bifida	N	N	N	N	N	N	N
lumbar-spondylolysis	N	N	N	N	N	P	N
MEASUREMENTS (mm)							
Cranial length	175	177	179	173	182	M	181
cranial breadth	144	138	123	142	144	M	140
basi-bregmatic height	FU	122	123	133	124	M	136
basi-nasal length	95	100	104	99	92	101	103
basi-prosthion length	96	91	101	93	93	94	98
biasterionic breadth	113	108	105	110	114	M	104
auricular height	118	106	108	112	112	M	111
biauricular breadth	129	121	125	M	134	M	126
minimum frontal breadth	96	92	85	90	95	M	91
maximum frontal breadth	FU	110	100	111	115	M	111
bistephanic breadth	FU	109	92	106	109	M	102
bijugal breadth	118	106	114	114	119	M	113
bizygomatic breadth	140	M	132	M	139	M	131
upper facial height	69	69	70	66	69	65	67
biorbital breadth (lateral)	107	99	104	100	106	91	102
biorbital breadth (medial)	21	20	24	18	20	22	21
orbital height	34	38	34	34	37	34	33.9
orbital breadth	40	38	38	38	38.5	36	37
nasal height	50	50	52	48	50	49	49
nasal breadth	23	25	27	23	26	26	23
cheek height	26	22	25	24	28	23	25
palatal length	47	44	50	47	46	44	44
palatal breadth	38	36.9	44.4	39	43.4	37	38.6
foramen magnum length	33	34.8	31.5	M	33	M	35.5
foramen magnum breadth	29	29.5	30	M	25	M	29.6

mid-orbital breadth	FU	49	61	46	63	54	51
horizontal circumference	515	498	49.2	505	524	M	510
bimaxillary chord	105	89	97	93	102	87	100
maxillo-alveolar breadth	62	57	62	60	65	55	59
inferior malar length	27	M	34	37	34	M	32
simotic chord	7	10	10	9	5	8	10.5
bifrontal chord	96	93	98	93	98	91	93
bifrontal subtense	18	23	23	18	14	24	19
zygomaxillary subtense	27	27	25	24	26	23	29
bimaxillary subtense	36	30	32	29	28	30	33
horizontal malar chord	60	M	52	57	54	M	54
horizontal malar subtense	11	M	12	10	14	M	12
vertical malar chord	45	47	51	48	52	M	46
frontal chord	FU	106	104	106	113	M	108
frontal subtense	FU	23	22	21	29	M	22
frontal fraction	FU	40	49	56	52	M	55
frontal arc	FU	118	116	117	135	M	122
parietal chord	FU	106	105	102	112	M	104
parietal subtense	FU	23	19	22	22	M	20
parietal fraction	FU	65	53	55	62	M	55
parietal arc	FU	118	113	113	123	M	115
occipital chord	FU	85	90	M	88	M	104
occipital subtense	FU	27	31	M	32	M	30
occipital fraction	FU	44	43	M	42	M	52
occipital arc	FU	108	113	M	115	M	123
horizontal malar arc	68	M	55	59	60	M	63
vertical malar arc	49	48	50	50	55	M	50
cranial index	82.3	78	68.7	82.1	79.1	M	77.3
cranial height/breadth index	FU	88.4	100	93.7	86.1	M	97.1
cranial height/length index	FU	68.9	68.7	76.9	68.1	M	75.1
auricular index	67.4	59.9	60.3	64.7	M	M	61.3
upper facial index	49.3	M	53	M	49.6	M	51.1
transv. Cranio-facial index	68.6	M	64.4	M	68.3	M	69.5
transv. Frontoparietal index	66.7	66.7	69.1	63.4	65.9	M	65
orbital index	85	100	89.5	89.5	96.1	94.4	91.6
nasal index	46	50	51.9	47.9	52	53.1	46.9
palatal index	80.9	83.9	88.8	83	M	84.1	87.7
gnathic index	101.1	91	97.1	93.9	101.1	93.1	95.1
frontal chord/arc index	FU	89.8	89.7	90.6	M	M	88.5
parietal chord/arc index	FU	89.8	92.9	90.3	M	M	90.4
occipital chord/arc index	FU	78.7	79.6	M	M	M	84.6
MANDIBLE							
symphyseal height	30	31	31	30	33	27	30
body length	103	103	108	103	105	99	105
ramus height	61	53	56	70	62	54	72
bigonial breadth	76	76	90	88	87	70	77
body height	29	25	31	30	32	26	28
body thickness	12	10	11	M	16	10	12
maximum ramus breadth	41	42	43	43	40	43	46
minimum ramus breadth	36	34	35	34	33	34	37
gonial angle	110	118	123	112	111	112	112
bicondylar breadth	123	111	118	120	116	95	116

CLAVICLE							
maximum length	137	120	139	149	138	M	127
midshaft circumference	40	28	32	40	40	M	32
maximum midshaft diameter	12	10	11	14	13	M	13
STERNUM							
maximum body length	91	M	91	111	108	M	101
SCAPULA							
glenoid breadth	28	M	22	27	M	23	27
glenoid cav. Length	37	M	35	35	M	34	41
maximum length	152	M	132	169	140	M	151
maximum breadth	98	M	91	100	86	95	104
length of spine	126	M	119	136	108	M	142
HUMERUS							
maximum length	295	275	304	327	310	304	340
maximum midshaft diameter	71	20	20	23	23	18	69
maximum trans diameter head	42	45	37	45	42	M	44
maximum vert diameter head	37	M	32	34	M	M	39
biepicondylar width	63	45	55	58	M	52	57
articular width	45	M	36	43	M	39	42
ULNA							
maximum length	244	221	242	266	243	M	261
midshaft diameter (a-p)	15	13	15	13	15	13	13
midshaft diameter (trans)	14	10	13	15	16	11	15
RADIUS							
maximum length	230	206	222	252	230	M	245
midshaft diameter (a-p)	11	13	12	13	12	9	14
midshaft diameter (trans)	15	10	10	17	16	11	12
head diameter	22	M	M	23	19	18	21
INNOMINATE							
iliac breadth	157	132	142	154	136	133	141
maximum length	212	M	195	212	203	192	206
acetabular diameter	53	M	50	52	51	46	50
sciatic notch width	52	32	55	50	48	42	M
cotylosciatic breadth	M	M	35	M	68	32	36
SACRUM							
maximum ant height	112	M	113	115	117	M	102
maximum ant breadth	123	M	110	109	101	M	109
FEMUR							
maximum length	418	377	417	457	426	410	470
femoral circumference	93	81	82	90	92	75	90
maximum diam head	47	42	43	47	45	42	47
FIBULA							
maximum length	335	M	M	366	349	332	355
TIBIA							
maximum length (with mm)	342	316	345	368	357	360	357
maximum length (wo. Mm)	331	M	340	360	349	348	M
circumference at nutr f	96	86	80	98	95	83	95
ant-post diam nutr f	32	23	22	37	24	21	25
med-lat diam nutr f	26	28	28	23	35	30	37
TALUS							
maximum length	56	54	55	56	54	54	58
maximum width	42	42	39	44	36	39	43

body height	33	32	30	33	30	29	34
maximum trochlear width	32	31	28	32	28	29	33
maximum trochlear length	32	31	32	33	32	31	33
CALCANEUS							
body min height	40	33	37	37	40	31	46
anterior breadth	42	41	40	45	39	35	40
max length	76	71	75	80	69	75	77

Appendix A2 - Inventory, Metrics and Nonmetrics of Burial Units 17 to 28

Burial Feature Number	**17**	**18**	**20**	**23**	**24**	**28**
Cranium						
Complete	P	P		P		
frontal					FI	FI
occipital					FI	FI
r. parietal					FI	FI
l. parietal					FI	FI
r. temporal					P	P
l. temporal					P	FI
r. zygomatic					P	P
l. zygomatic					N	N
r. maxilla					N	P
l. maxilla					N	FI
r. sphenoid					FI	FI
l. sphenoid					FI	FI
mandible	P	P		P	FI	P
sternum						
manubrium	P	P		P	P	P
body	P	P		P	P	F
xiphoid					P	
left ribs	11	12		11	11	11
right ribs	11	12		11	10	7
carpals						
r. scaphoid	P	P		P	P	P
l. scaphoid	P	P		P	P	N
r. lunate	P	P		P	P	P
l. lunate	P	P		P	P	P
r. triangular	P	N		P	P	N
l. triangular	P	P		N	P	P
r. pisiform	P	N		P	P	P
l. pisiform	P	P		N	P	N
r. trapezium	P	P		P	P	FI
l. trapezium	P	P		P	P	P
r. trapezoid	P	P		P	P	P
l. trapezoid	P	P		P	P	P
r. capitate	P	P		P	P	P
l. capitate	P	P		P	P	N
r. hamate	P	P		P	P	N
l. hamate	P	P		P	P	P
r. metacarpal 1	P	P		P	P	N
l. metacarpal 1	P	P		P	P	P
r. metacarpal 2	P	P		P	P	P
l. metacarpal 2	P	P		P	P	FI
r. metacarpal 3	P	P		P	P	N
l. metacarpal 3	P	P		P	P	P
r. metacarpal 4	P	P		P	P	P
l. metacarpal 4	P	P		P	P	N
r. metacarpal 5	P	P		P	P	N

l. metacarpal 5	P	P	P	P	P
prox manus phalanges	10	9	10	10	3
mid manus phalanges	8	5	7	8	2
distal manus phalanges	10	7	7	6	0
r. scapula	I	P	FI	FI	P
l. scapula	I	P	FI	FI	FI
r. clavicle	P	P	P	P	P
l. clavicle	P	P	P	FI	I
r. humerus	P	P	P	P	F
l. humerus	P	P	P	FI	P
r. radius	P	P	P	FI	P
l. radius	P	P	P	P	P
r. ulna	P	P	P	P	F
l. ulna	P	P	P	P	P
r. innominate	P	P	P	P	FI
l. innominate	P	P	P	FI	FI
r. femur	P	P	P	FI	P
l. femur	P	P	P	FI	FI
r. tibia	P	P	P	P	FI
l. tibia	P	P	P	P	FI
r. patella	P	P	P	P	P
l. patella	P	N	P	P	P
r. fibula	P	P	P	P	FI
l. fibula	I	P	P	FI	FI
tarsals					
r. calcaneus	P	P	P	P	P
l. calcaneus	P	P	P	P	P
r. talus	P	P	P	P	P
l. talus	P	N	P	P	P
r. cuboid	P	P	P	P	P
l. cuboid	P	P	P	P	P
r. navicular	P	P	P	P	P
l. navicular	P	P	P	P	P
r. cuneiform 1	P	P	P	P	P
l. cuneiform 1	P	P	P	P	P
r. cuneiform 2	P	P	P	P	P
l. cuneiform 2	P	P	P	P	P
r. cuneiform 3	P	P	P	P	P
l. cuneiform 3	P	P	P	P	P
r. metatarsal 1	P	P	P	P	P
l. metatarsal 1	P	P	P	P	P
r. metatarsal 2	P	P	P	P	P
l. metatarsal 2	N	P	P	P	P
r. metatarsal 3	P	P	P	P	P
l. metatarsal 3	P	P	P	P	P
r. metatarsal 4	P	P	P	P	P
l. metatarsal 4	P	P	P	P	P
r. metatarsal 5	P	P	P	P	N
l. metatarsal 5	P	P	P	P	P
prox pes phalanges	6	8	10	10	4
mid pes phalanges	3	2	4	7	0
distal pes phalanges	5	1	5	10	0

sesamoids	3	1	1	4	2
TEETH					
maxillary dentition					
RM3	P	N	P		N
RM2	P	P	P		P
RM1	P	P	P		P
RP2	P	P	P		P
RP1	P	P	P		P
RC	P	P	P		P
RI2	P	P	P		P
RI1	P	P	P		P
LI1	P	P	P		N
LI2	P	P	P		P
LC	P	P	P		P
LP1	P	P	P		P
LP2	P	P	P		P
LM1	P	P	P		P
LM2	P	P	P		P
LM3	P	N	P		N
mandibular dentition					
RM3	P	N	P		P
RM2	P	P	P		P
RM1	P	P	P		P
RP2	P	P	P		P
RP1	P	P	P	P	P
RC	P	P	P		P
RI2	P	P	P	P	P
RI1	P	P	P		P
LI1	P	P	P	P	P
LI2	P	P	P	P	P
LC	P	P	P	P	P
LP1	P	P	P	P	P
LP2	P	P	P	P	P
LM1	P	P	P		P
LM2	P	P	P		P
LM3	P	N	P		P
VERTEBRAE					
C1	P	P	P	P	P
C2	P	P	P	P	P
C3	P	P	P	P	P
C4	P	P	P	P	P
C5	P	P	P	P	P
C6	P	P	P	P	P
C7	P	P	P	P	P
T1	P	P	P	7PU	P
T2	P	P	P		P
T3	P	P	P		P
T4	P	P	P		P
T5	P	P	P		P
T6	P	P	P		P
T7	P	P	P		P
T8	P	P	P		P

T9	P	P	P		P
T10	P	P	P		P
T11	P	P	P	P	P
T12	P	P	P	P	P
L1	P	P	P	P	P
L2	P	P	P	P	P
L3	P	P	P	P	P
L4	P	P	P	P	P
L5	P	P	P	P	P
sacrum	P	P	P	P	1&2
caudal	1	1		1	
DISCRETE TRAITS					
Ossicle at lamda	N	N	N	M	N
Ossicle at asterion R	N	N	N	M	N
Ossicle at asterion L	N	N	N	M	N
Bregmatic bone	N	N	N	M	N
Inca bone	N	N	N	M	N
Parietal Notch Bone R	N	N	N	M	N
Parietal Notch Bone L	N	N	N	M	N
Pterionic Bone R	N	N	N	M	M
Pterionic Bone L	N	N	N	M	M
Lambdoid Ossicles R	P	P	N	N	M
Lambdoid Ossicles L	N	P	P	N	M
Sagittal Ossicles	N	N	N	M	N
Coronal Ossicles R	N	N	P	M	N
Coronal Ossicles L	N	N	P	M	N
Metopism	N	N	N	M	N
Mastoid Suture R	N	P	M	M	N
Mastoid Suture L	N	P	N	N	N
Bipartate Parietals R	N	N	N	M	N
Bipartate Parietals L	N	N	N	M	M
Os Japonicum R	N	N	N	M	M
Os Japonicum L	N	N	N	M	M
Fronto-temporal art R	N	M	N	M	M
Fronto-temporal art L	N	M	N	M	N
Suture into Infraorb F R	N	P	P	M	M
Suture into Infraorb F L	N	P	P	M	M
Obelionic F R	N	N	N	M	N
Obelionic F L	N	N	N	M	N
Secondary Frontal F R	N	N	N	M	M
Secondary Frontal F L	N	N	N	M	M
Acces Infra-orbital F R	P	N	N	M	M
Acces Infra-orbital F L	P	N	N	M	M
Access Mental F R	N	P	N	M	M
Access Mental F L	P	N	N	M	M
Acces Optic C R	N	N	N	M	M
Acces Optic C L	N	N	N	M	M
Ant Condylar C Bridge R	N	N	N	M	M
Ant Condylar C Bridge L	N	N	N	M	M
Post Condylar C Bridge R	N	N	N	M	M
Post Condylar C Bridge L	N	M	N	M	M
F of Huschke R	N	N	N	M	N

F of Huschke L	N	N	N	M	N
F Ovale Incomplete R	N	N	N	M	M
F Ovale Incomplete L	N	N	N	M	M
F Spinosum Open R	N	N	N	M	M
F Spinosum Open L	N	N	N	M	M
F of Versalius R	N	N	P	M	M
F of Versalius L	N	N	N	M	M
Supraorb Nerve Impress R	N	N	N	M	N
Supraorb Nerve Impress L	N	N	N	M	N
Bridge Mylohyoid Groove R	N	N	N	N	N
Bridge Mylohyoid Groove L	N	N	N	N	N
Pharyngeal Fossa	N	N	N	M	M
Condylar Facet Double R	N	N	N	N	M
Condylar Facet Double L	N	P	N	N	M
Precondylar Tubercle	N	N	N	M	M
Sagittal Keel	N	N	N	M	N
Occipital Bun	N	N	N	N	N
Palatine Torus	N	N	N	M	M
Maxillary Torus R	N	N	N	M	M
Maxillary Torus L	N	N	N	M	M
Auditory Exostosis R	N	N	N	M	N
Auditory Exostosis L	N	N	N	M	N
Absence Max 3rd molar R	N	P	N	M	M
Absence Max 3rd molar L	N	P	N	M	M
Absence Mand 3rd molar R	N	P	N	M	N
Absence Mand 3rd molar L	N	P	N	M	N
rotated max premolar 2 R	N	N	N	N	M
rotated max premolar 2 L	N	N	N	N	M
rotated mand premolar 2 R	N	N	N	N	N
rotated mand premolar 2 L	N	N	N	N	N
parietal foramen R	P	P	N	M	N
parietal foramen L	P	P	N	M	N
marginal foramen R	N	N	N	M	M
marginal foramen L	N	N	N	M	M
accessory hypoglossal canal R	N	N	N	N	M
accessory hypoglossal canal L	N	N	N	N	M
frontal grooves R	N	N	N	M	M
frontal grooves L	N	N	N	M	M
infraorbital suture R	N	M	P	M	M
infraorbital suture L	N	M	P	M	M
pterygoid bridge R	N	N	N	M	M
pterygoid bridge L	N	N	N	M	M
clinoid bridge R	M	M	M	M	M
clinoid bridge L	M	M	M	M	M
trochlear spur R	N	N	N	M	M
trochlear spur L	N	N	N	M	M
paracondylar process R	N	N	N	M	M
paracondylar process L	N	N	N	M	M
pharyngeal fossa R	N	N	P	M	M
sternum-sternal aperture	N	N	N	N	M
scapula-os acromiale R	P	N	N	N	N
scapula-os acromiale L	N	N	N	M	N

humerus-septal aperture R	N	N		P	N	N
humerus-septal aperture L	N	N		P	N	N
innominate-acetabular mark R	N	N		N	N	N
innominate-acetabular mark L	N	N		N	N	N
femur-third trochanter R	N	N		N	P	N
femur-third trochanter L	N	N		N	P	N
patella-vastus notch R	N	N		N	N	N
patella-vastus notch L	N	M		N	N	N
patella-bipartate R	N	N		N	N	M
patella-bipartate L	N	M		N	N	M
tibia-dist ant squat facet R	P	N		N	P	N
tibia-dist ant squat facet L	P	P		N	P	N
calcaneus-bipart ant talar facet R	P	N		N	N	N
calcaneus-bipart ant talar facet L	P	N		P	N	N
talus-os trigonum R	N	N		N	N	N
talus-os trigonum L	N	M		N	N	N
atlas-f transversarium incomp R	N	N		N	N	N
atlas-f transversarium incomp L	N	N		N	N	N
atlas-spina bifida	N	N		N	N	N
atlas-bifid anterior arch	N	N		N	N	N
axis-f transversarium incomp R	N	N		N	N	N
axis-f transversarium incomp L	N	N		N	P	N
cervicle-f. transversarium bridge R	N	P		M	P	P
cervicle-f. transversarium bridge L	N	M		P	P	P
cervicle-spina bifida	N	N		N	N	N
lumbar-spondylolysis	N	N		P	N	N
sacrum-spina bifida of 1st	N	N		N	N	N
sacrum-spina bifida lower sacrum	N	N		N	N	N
MEASUREMENTS						
Cranial length	174	180	M	164	M	M
cranial breadth	144	138	116	130	M	M
basi-bregmatic height	140	126	M	120	M	M
basi-nasal length	98	98	M	92	M	M
basi-prosthion length	95	94	M	97	M	M
biasterionic breadth	109	110	M	101	M	M
auricular height	112	110	M	101	M	M
biauricular breadth	123	119	M	120	M	M
minimum frontal breadth	101	87	86	87	M	M
maximum frontal breadth	123	M	96	103	M	M
bistephanic breadth	123	M	M	104	M	M
bijugal breadth	116	108	M	113	M	M
bizygomatic breadth	133	125	M	128	M	M
upper facial height	70	73	52	65	M	M
biorbital breadth (lateral)	106	99	88	102	M	M
biorbital breadth (medial)	20	18	18	18	M	M
orbital height	34	38	30	33	M	M
orbital breadth	37	37	34	39	M	M
nasal height	51	52	38	47	M	M
nasal breadth	26	23	20	25	M	M
cheek height	26	23	20	19	M	M
palatal length	48	44	M	47	M	M
palatal breadth	39.5	34.5	28.5	36	M	M

foramen magnum length	34.7	35	M	36	M	M
foramen magnum breadth	31.9	29	M	28	M	M
mid-orbital breadth	48	48	47	59	M	M
horizontal circumference	520	500	M	475	M	M
bimaxillary chord	95	91	75	92	M	M
maxillo-alveolar breadth	62	58	48	59	M	M
inferior malar length	32	37	M	33	M	M
simotic chord	7	10	11	6	M	M
bifrontal chord	97	90	81	95	M	M
bifrontal subtense	14	21	17	16	M	M
zygomaxillary subtense	27	28	22	23	M	M
bimaxillary subtense	31	36	M	35	M	M
horizontal malar chord	55	57	M	50	M	M
horizontal malar subtense	12	12	M	11	M	M
vertical malar chord	48	48	M	41	M	M
frontal chord	116	109	102	100	M	M
frontal subtense	30	23	25	22	M	M
frontal fraction	55	65	43	52	M	M
frontal arc	135	125	118	111	M	M
parietal chord	107	107	108	95	M	M
parietal subtense	22	18	20	19	M	M
parietal fraction	52	59	49	52	M	M
parietal arc	117	114	M	103	M	M
occipital chord	96	101	M	89	M	M
occipital subtense	27	33	M	26	M	M
occipital fraction	50	50	M	41	M	M
occipital arc	113	125	M	106	M	M
horizontal malar arc	63	61	M	55	M	M
vertical malar arc	50	48	M	42	M	M
cranial index	82.8	76.7	M	79.3	M	M
cranial height/breadth index	97.2	91.3	M	92.3	M	M
cranial height/length index	80.5	70	M	73.2	M	M
auricular index	64.4	61.1	M	61.6	M	M
upper facial index	52.6	58.4	M	50.8	M	M
transv. Cranio-facial index	75.9	69.6	M	68	M	M
transv. Frontoparietal index	70.1	63	M	66.9	M	M
orbital index	91.9	102.7	M	84.6	M	M
nasal index	51	44.2	M	53.2	M	M
palatal index	82.3	78.4	M	76.6	M	M
gnathic index	96.9	95.9	M	105.4	M	M
frontal chord/arc index	85.9	87.2	M	90.1	M	M
parietal chord/arc index	91.5	93.9	M	92.2	M	M
occipital chord/arc index	85	80.8	M	84	M	M
MANDIBLE						
symphyseal height	35	29		30	36	28
body length	111	109		105	107	102
ramus height	72	60		56	66	58
bigonial breadth	81	80		71	84	82
body height	32	31		28	36	25
body thickness	11	12		9	12	11
maximum ramus breadth	39	47		48	38	43
minimum ramus breadth	32	35		37	29	34

gonial angle	122	124	124	115	120
bicondylar breadth	120	116	108	M	115
CLAVICLE					
maximum length	157	142	131	160	137
midshaft circumference	43	35	M	46	37
maximum midshaft diameter	14	11	9	14	13
STERNUM					
maximum body length	120	M	82	106	M
SCAPULA					
glenoid breadth	30	24	22	M	27
glenoid cav. Length	43	34	30	M	35
maximum length	165 (f)	136	144	M	141
maximum breadth	109	99	94	M	98
length of spine	144	125	121	M	124
HUMERUS					
maximum length	341	331	290	334	307
maximum midshaft diameter	76	20	20	21	20
maximum trans diameter head	M	37	37	43	41
maximum vert diameter head	M	32	31	35	32
biepicondylar width	M	50	54	M	51
articular width	53	36	38	42	38
ULNA					
maximum length	269	254	240	265	238
midshaft diameter (a-p)	14	12	11	17	13
midshaft diameter (trans)	21	11	12	12	12
RADIUS					
maximum length	247	238	221	250	220
midshaft diameter (a-p)	15	15	10	16	13
midshaft diameter (trans)	19	11	10	11	11
head diameter	26	20	19	22	23
INNOMINATE					
iliac breadth	M	M	151	150	150
maximum length	224	M	190	202	M
acetabular diameter	61	M	45	53	50
sciatic notch width	44	M	58	54	M
cotylosciatic breadth	M	M	29	37	M
SACRUM					
maximum ant height	120	114	100	108	M
maximum ant breadth	116	119	112	118	120
FEMUR					
maximum length	484	426	425	445	420
femoral circumference	M	82	77	90	80
maximum diam head	52	42	42	47	45
FIBULA					
maximum length	358	349	313	M	M
TIBIA					
maximum length (with mm)	370	362	330	362	336
maximum length (wo. Mm)	360	347	317	351	325
circumference at nutr f	105	88	73	90	82
ant-post diam nutr f	37	21	18	32	23
med-lat diam nutr f	29	33	26	23	29
TALUS					

maximum length	60	50	52	55	54
maximum width	47	36	37	41	39
body height	36	29	30	32	29
maximum trochlear width	36	27	27	31	28
maximum trochlear length	39	29	28	37	30
CALCANEUS					
body min height	42	35	32	36	36
anterior breadth	44	38	37	44	41
max length	85	72	69	79	72

Appendix B: Inventory of Surface Scatter Skeletal Remains

Grouped according to estimated age:

Surface scatter 1 – this group contains the partial skeletal remains from two 4-5 year olds. Most likely associated with burial feature 4.

femurs– right maximum length 235 mm
left
right maximum length 252 mm
left
left distal epiphysis (47 mm wide)
left distal epiphysis (51 mm wide)
proximal epiphysis

tibial epiphysis – right proximal (42 mm)
tibia – left – maximum length 202 mm
humeri – left and right – maximum length 187 mm
humeral epiphyses (2 proximal – 30 mm)
radius – maximum length 138 mm
ulna – maximum length 149 mm
ilium – width 83 mm
ischium (2)
pubis
distal humerus
clavicle (90mm)
cervical vertebra (C2)
vertebral fragments – posterior arches (7), centrae (2)
thoracic vertebra
scapula (left – fragmented and incomplete)
maxilla – mixed dentition with the first permanent molars erupted
mandible – mixed dentition, first permanent molars erupted
parietal – left and right – fragmented and incomplete
temporal – left and right – fragmented and incomplete
molar
incisor (first) – 12 mm

Surface Scatter 2 – estimated age of 3 years

tibia – right – maximum length 176 mm

femur – left – (curved – fragmented and incomplete)

femoral epiphyses – left and right proximal – 34 mm wide

parietal – right – fragmented and incomplete

occipital – fragment from basi-occipital

humeral proximal epiphysis

calcaneus – right – length 40 mm

maxilla – with deciduous first and second, left and right molars

temporal – petrous fragment – both left and right

rib – first right

Surface Scatter 3 – estimated age of 12 to 15 years

partial cranium – frontal, right parietal

parietal fragments (2)

maxilla – left and right separate (right mesially rotated second premolar)

basi-occipital

zygomatic – right

sphenoid fragments (2) – from greater wings

coracoid process – unfused

temporal – right

temporal – petrous – left

maxilla – second molars erupted with wear

vertebrae – 3 thoracic

Surface Scatter 4 – estimated age of 40 weeks

humerus – right – maximum length 65 mm

femur – left – maximum length 73 mm

ulna – left – maximum length 59 mm

tibia – right – maximum length 60 mm

temporal – petrous fragment – 32 mm

zygomatic – right – 22 mm high

sphenoid – greater wing – right – 32 mm wide
lesser wing – left

ilium – right – 40 mm

mandible – right side – 52 mm long

Surface Scatter 5 – estimated age of 3-4 months

femur – right – maximum length 104 mm

tibia – right – maximum length 82 mm

tibia – left – maximum length 87 mm (swollen)

humerus – left – maximum length 82 mm

ilium – right – 43 mm

Surface Scatter 6 – estimated age of 32 fetal weeks possibly associated with Feature 5

tibia – fragmented and incomplete

Surface Scatter 7 – estimated age of 2 years

tibia – left – proximal

mandible – left half with deciduous canine erupted

maxilla – left – first deciduous molar erupted

Appendix C: Inventory of unmatched skeletal fragments

metacarpals (4)

metatarsals (2-5th, 1-1st, 1 unidentified)

phalanges – distal – 6

mid – 2

prox – 2

femoral distal epiphysis – fragmented and incomplete

radial distal epiphysis – fragmented and incomplete

hyoid

sternabrae (2)

zygomatic – right – height of 27 mm

manubrium – 19 mm x 19 mm

ribs – 7 left fragments, 6 right fragments and 18 unidentified fragments

vertebral bodies – 8

vertebral posterior arch halves – 18

misc. cranial fragments – 40

sphenoid fragments – 10

innominate fragments – 3

long bone fragments – 9

epiphyses – 8

miscellaneous – unidentified 40 small fragments

teeth – 2 deciduous molars, 3 deciduous incisors, 1 permanent canine